Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

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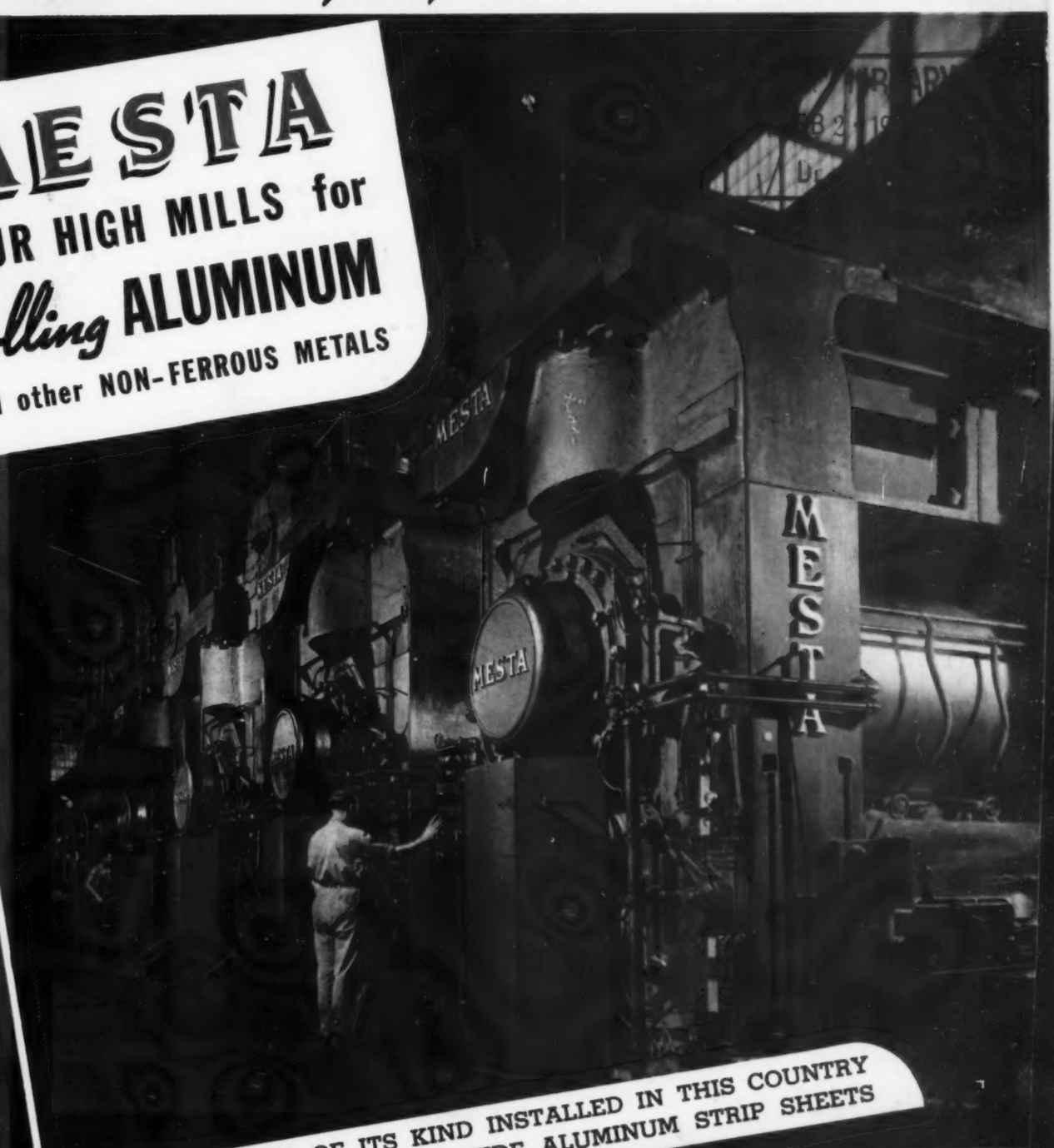
MESTA

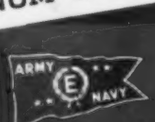
FOUR HIGH MILLS for *Rolling* ALUMINUM

and other NON-FERROUS METALS



Send for your copy of this 64 page booklet containing valuable engineering data. Address your requests to Dept. A-1

THE FIRST MILL OF ITS KIND INSTALLED IN THIS COUNTRY FOR THE PRODUCTION OF WIDE ALUMINUM STRIP SHEETS



The Army-Navy "E" Flag with four stars, flies over the Mesta Plant.

MESTA MACHINE COMPANY • Pittsburgh, Pa.

Multiple control can be housed in a UNITROL Section alongside the machine it serves

To All Users of Motor Control

HOW TO BUY FOR TODAY and be READY FOR TOMORROW

Control for a machine group or department can be centralized in nearby unused space.

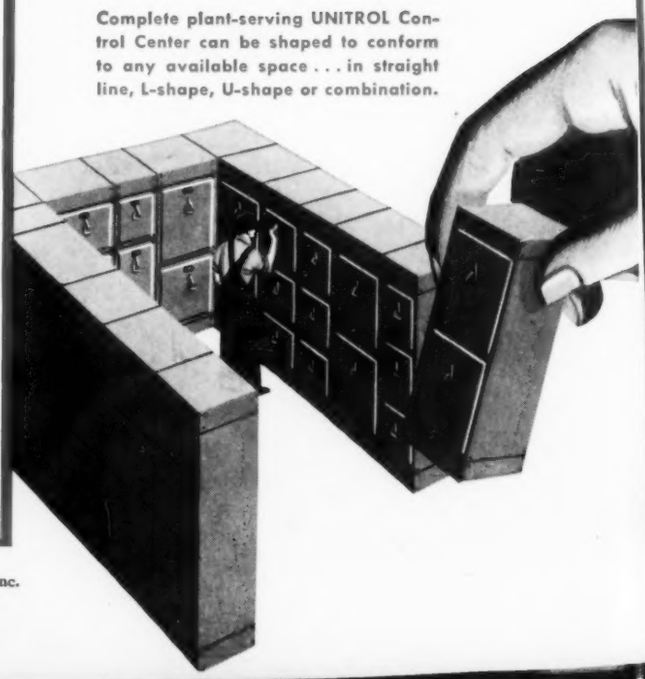
The motor control you buy today *can* be a wise investment that will better prepare your plant for peacetime reconversion simply *insist on UNITROL*, the *unitized* and interchangeable control equipment that can be "converted" at will!

Here's why UNITROL is a sensible buy today. It lets you get 2 to 3 times as much control into the same space, lets you arrange your plant's motor control to conform to individual needs, lets you take advantage of "odds and ends" of space and meet your particular manpower requirements. It installs fast, needing only to be electrically connected.

Here's why UNITROL is a good investment for tomorrow. UNITROL is like your sectionalized filing cabinets. Each control unit can be removed easily and quickly, placed in some other compartment, or replaced. Entire sections can be shifted or removed. The complete plant-serving UNITROL control center can be reshaped, reorganized or expanded as your post-war operations demand.

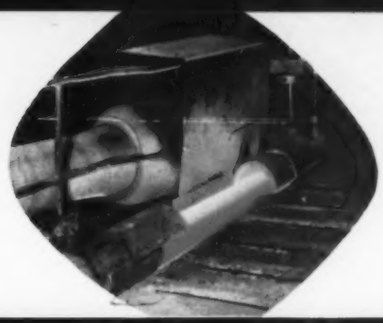
Before you buy *any* motor control now, send for the 36-page UNITROL book. It's free. Write today. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee, Wisconsin.
Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

Complete plant-serving UNITROL Control Center can be shaped to conform to any available space . . . in straight line, L-shape, U-shape or combination.



CUTLER-HAMMER
UNITROL
C-H

Copyright, 1943, Cutler-Hammer, Inc.



Aetna-Standard Has Built 23 Seamless Tube Mills—

REMEMBER when a 20 foot length of 6 inch was a whopping big piece of tubing? This was back in the days when Aetna-Standard built its first seamless tube mill... 1904. Since that time, we have engineered and constructed, in our modern plants, almost all the seamless tube mills in this country as well as many abroad.

Today, mills built by Aetna-Standard make the biggest seamless tubing . . . lengths of 50 feet, diameters of 24 inches and all sizes in between, down to 1½ inch. The pipe for the famous "Big Inch" line was produced on a mill made by Aetna-Standard.

Many improvements have been introduced and pioneered by our experienced engineers since the first mill was built. Pipe diameters have grown and production speed has been increased. Maintenance cost has been decreased by the application of sturdier designs . . . the use of anti-friction bearings . . . well engineered lubricating systems for oil and grease.

Operating costs have been decreased by improved motor adjustments for rolls, screw-downs, guides, etc. . . . the use of electric power instead of air or manual power . . . the use of overhanging rolls, closer roll centers and individual motor drives for reducing and sizing mills . . . the use of better bar supports for piercer and reeler outlet tables.

There is a sound reason why Aetna-Standard has built most of the seamless tube mills for ferrous and non-ferrous metals. Our engineers and designers are practical men. They have worked in mills. They know what is needed in tube mills and most important, how to build it. These men not only build and install Aetna seamless tube mills, but they actually operate them during the breaking-in period.

Aetna-Standard not only manufactures seamless tube mills, but they also make lap and butt weld pipe mills, as well as rolls and auxiliary equipment . . . threaders, cut off and straightening machines and hydrostatic testing equipment. So, when you need production machinery engineered and built into your plant, remember that Aetna-Standard can do either the complete job for you or any part thereof.

The AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN · OHIO · U.S.A.
ARMY E NAVY

Facts About AETNA-STANDARD

To produce precision equipment such as seamless tube mills, thousands of intricate pieces of all sizes, weights, and shapes must be integrated. Aetna-Standard prepares many parts in its own large and versatile machine shops, which are complete with grinders, lathes, planers, radial drills, and other machine shop facilities. Experienced machinists use the same care in machining huge castings as they do in machining small intricate parts.

Aetna-Standard operates these large modern machine shops so that quantities of the finished products can be closely controlled. The fact that equipment engineered by Aetna-Standard always delivers the goods illustrates the soundness of this policy.

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

√R v.21 Ja-Je 1944

It's the GUIDE *that leads the way*

—SEE THAT IT IS CHOSEN WITH CARE!

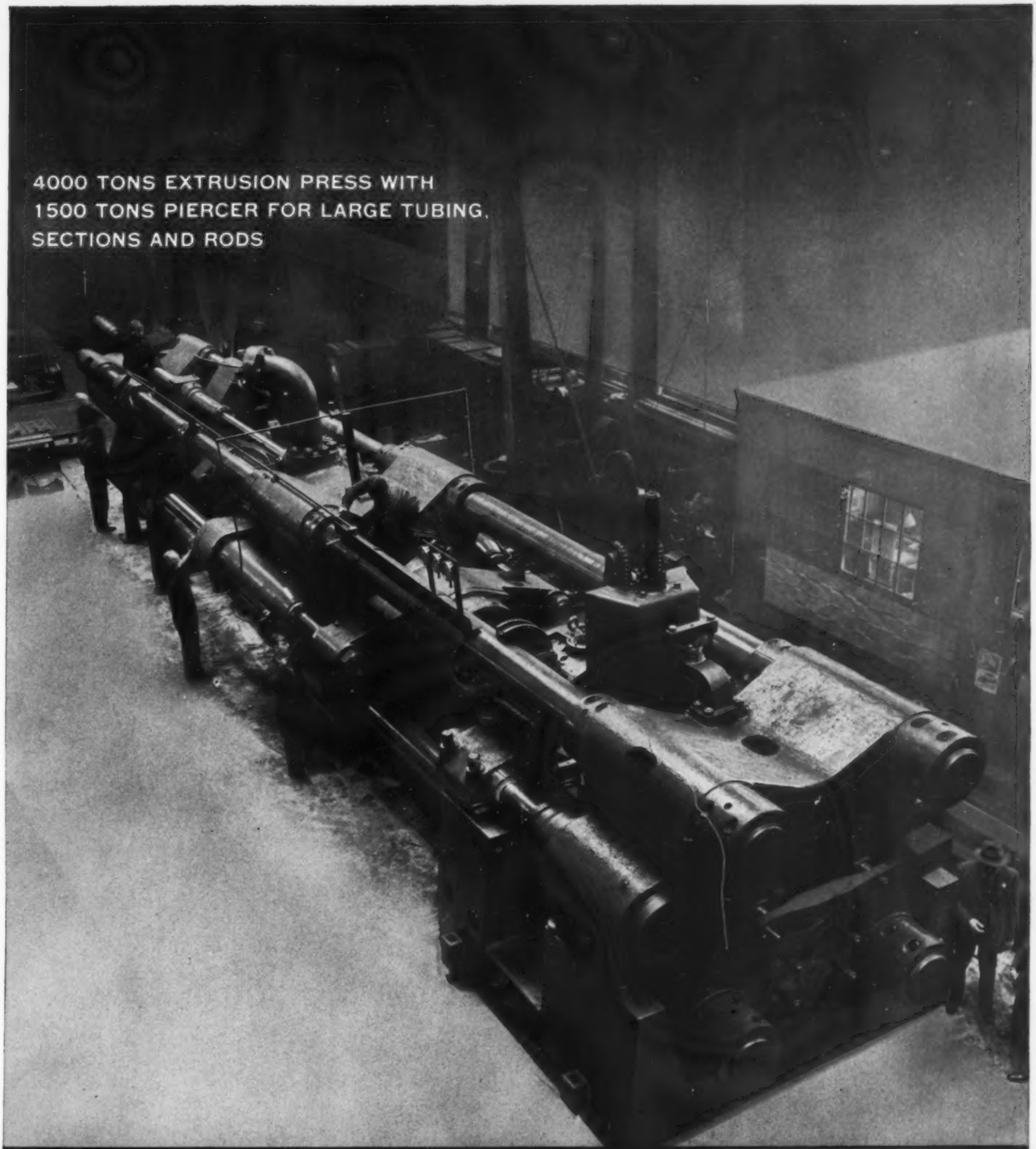
TRANTINYL

THE LEADING GUIDE IN
THE STEEL INDUSTRY

Youngstown Alloy Casting Corporation

YOUNGSTOWN, OHIO

Tech.



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WEAN

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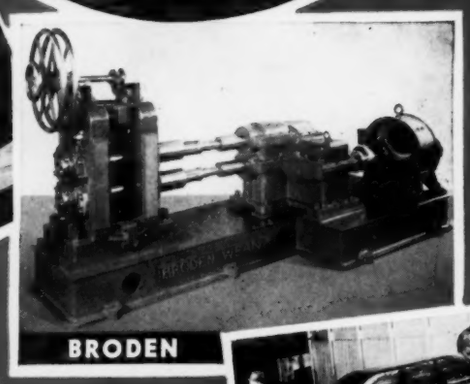
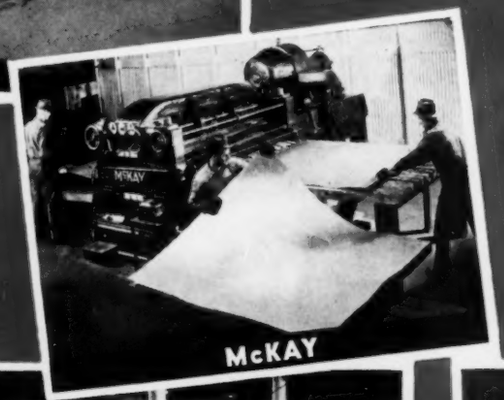
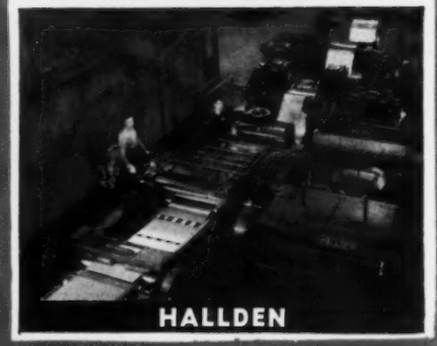

BRODEN



McKAY

SPECIALISTS IN SHEET, TIN & STRIP MILL EQUIPMENT

FLINN & DREFFEIN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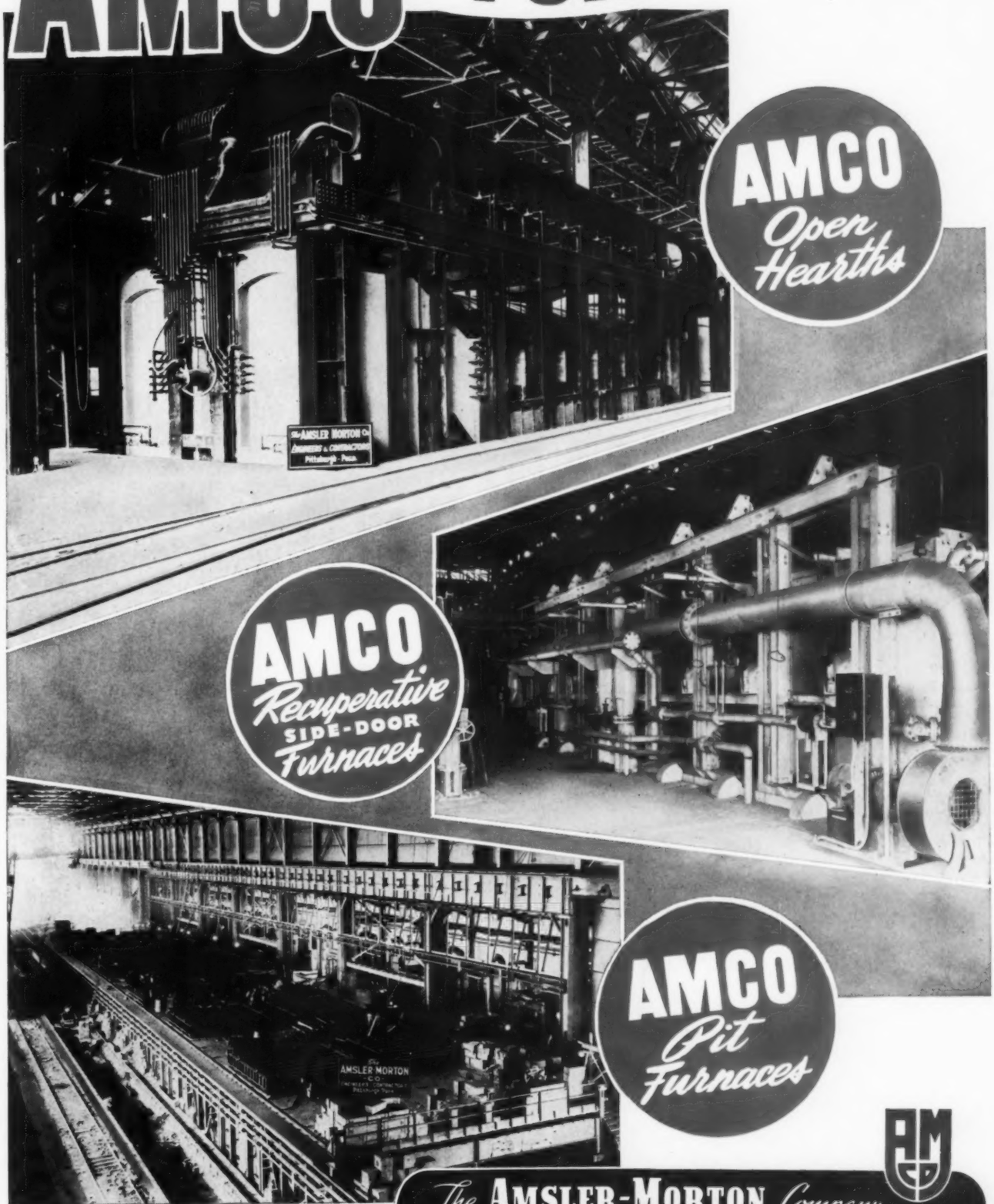
AMCO INDUSTRIAL FURNACES



The AMSLER-MORTON Company
FULTON BUILDING · PITTSBURGH, PA.

THE BIG BERTHAS OF THIS WAR ARE ALLIANCE CRANES

As world's largest builders of world's largest cranes, Alliance has installed an unprecedented number of heavy tonnage cranes during the war. Here are a few:

Nine 200-ton ladle cranes. Capacity–100 to 300 tons.
Twenty-five soaking pit cranes. Capacity–10 to 60 tons.
Thirty 200-ton ladle cranes. Capacity–100 to 300 tons.
Ten electro-hydraulic cranes located in Armor-plate producing plants. Capacity–200 to 300 tons.
Eighteen cranes in one Naval Ordnance plant. Capacity–125 to 200 tons.

All of these cranes were designed and built in accordance with specifications developed by The Alliance Machine Company, during nearly a half century of service to the steel industry.

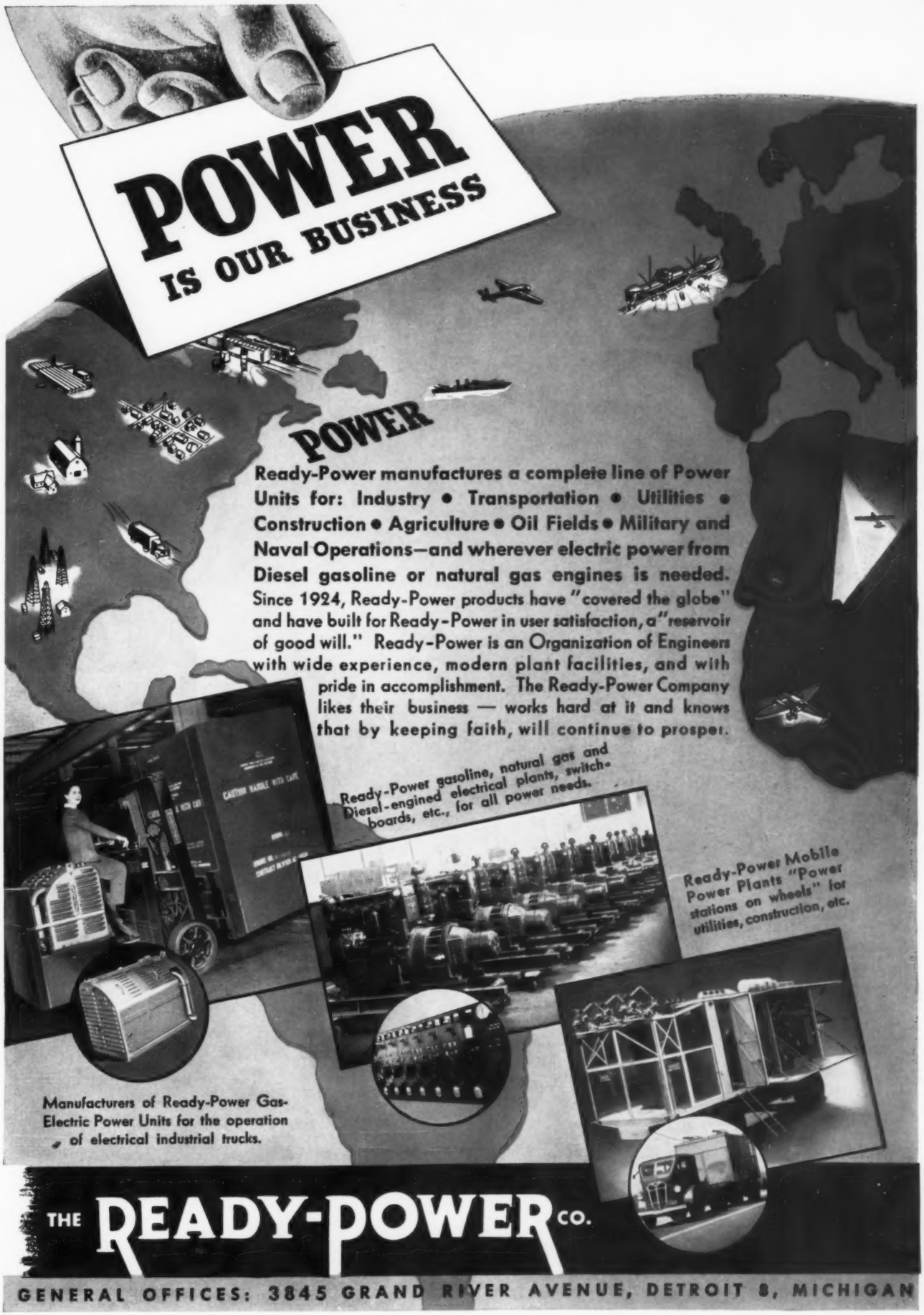
Sustained high production depends on rapid, accurate, safe manipulation of heavy loads over long periods without shutdowns.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES OPEN HEARTH CHARGING MACHINES

Alliance

THE ALLIANCE MACHINE CO., ALLIANCE, OHIO • • • SPECIAL AND STANDARD CRANES FOR HEAVY DUTY

POWER
IS OUR BUSINESS



POWER

Ready-Power manufactures a complete line of Power Units for: Industry • Transportation • Utilities • Construction • Agriculture • Oil Fields • Military and Naval Operations—and wherever electric power from Diesel gasoline or natural gas engines is needed. Since 1924, Ready-Power products have "covered the globe" and have built for Ready-Power in user satisfaction, a "reservoir of good will." Ready-Power is an Organization of Engineers with wide experience, modern plant facilities, and with pride in accomplishment. The Ready-Power Company likes their business — works hard at it and knows that by keeping faith, will continue to prosper.

Ready-Power gasoline, natural gas and Diesel-engined electrical plants, switchboards, etc., for all power needs.

Ready-Power Mobile Power Plants "Power stations on wheels" for utilities, construction, etc.

Manufacturers of Ready-Power Gas-Electric Power Units for the operation of electrical industrial trucks.

THE READY-POWER CO.

GENERAL OFFICES: 3845 GRAND RIVER AVENUE, DETROIT 8, MICHIGAN

BAILEY PRODUCTS
—giving the Steel Industry maximum Victory production!
The Thermal Goggle Valve
The Open Joint Stove Checker
The Electric Plunger Clay Gun
The Double Shaft Pug Mill
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The Bailey Mechanical Valve
Fabricated Steel Stove Bottom
The Cinder Notch Stopper
Sintering Plant Pug Mill
Precision Table Feeder
Water Metering Method
Blast Furnace Cold Blast Valve
Blast Furnace Blow-Off Valve
Check and Snort Valve
Mixing and Check Relief Valve
Ladle Skulling Hook
Gas Seal for Gauge Rods
WILLIAM M. BAILEY COMPANY Engineers PITTSBURGH, PENNSYLVANIA

WHY does

Engr. Dept:
Better have these
folks talk to us.
C.J.M.

One Company use 9 BILLETEERS?
and another use 6 BILLETEERS?
Why do Four use 4 BILLETEERS?
and 3 others have 2 BILLETEERS?
and so on . . .

BONNOT PRODUCTS
ENGINEERED
FOR IMPROVED
PRODUCTION

Because Billeteers

SAVE TIME CLEAN 20 BILLETS TO ONE THE OLD WAYS
SAVE METAL SALVAGE WHOLE HEATS THAT GO BAD
SAVE MEN FOR OTHER IMPORTANT JOBS
SAVE POWER A 60 PERCENT KWH SAVING

AND THESE FOUR WILL SPEED VICTORY

WRITE US

THE BONNOT COMPANY
CANTON, OHIO

BONNOT

ENGINEERED FOR IMPROVED PRODUCTION

2 NEW magnets by EC&M

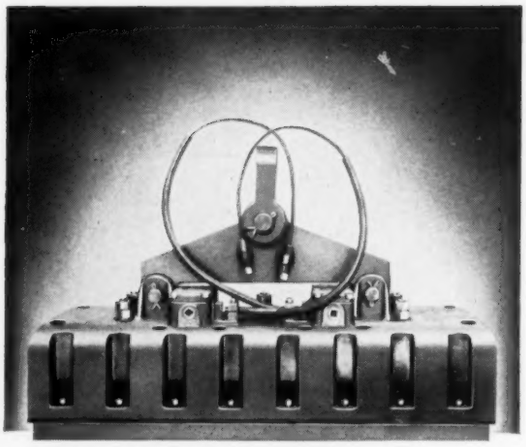
EC&M 65-in. diam. No. 6D Type SA Magnet

NO. 6D FOR OPEN-HEARTH STOCK YARD SERVICE

Handles More Tonnage in Less Time

You can judge from the view above something about the load this magnet carries—actually from 20% to 25% more—making it ideal for open-hearth stock yard and similar service.

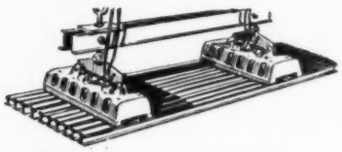
By conforming to size of charging boxes, it permits quick filling with minimum spillage. And with the standard automatic-discharge controller, the load is released quickly and cleanly. Ask for complete information—EC&M No. 6D.



EC&M Type BR Rail and Billet Magnet

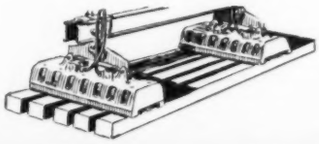
TYPE BR FOR HANDLING BILLETS, RAILS AND OTHER FINISHED PRODUCTS

Coils are Circular-wound of Strap-Copper



Here's something brand new in rectangular magnet design. Circular coils with strap copper, resulting in mean-turn of small length, tight winding and high magnetic intensity with reduced power consumption.

Two or three coils in individual, hermetically sealed cases are used. Other features are: water-proof terminal boxes; Class B insulation; renewable pole shoes; and suspension hanger permitting 2-way tilt of magnet and load.



Send for NEW BULLETIN 901

THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street ★ Cleveland 4, Ohio

REPORTING *on the use of*

Linde Methods

in mass production..

METAL FABRICATING · · · *if you work with metals, you should know more about these Linde Methods for* "Carpentry in Steel."

In this picture, a Unionmelt electric welding machine is joining automatically the edges of steel plate being fabricated into a pressure vessel . . . making uniformly strong welds . . . at high speed. Other Unionmelt machines . . . mounted on light, overhead cranes . . . are working on semi-finished structures further down the line.

Unionmelt welding was developed by The Linde Air Products Company. Other Linde methods . . . the "flame" methods . . . are also important to the complete picture of joining metals. Oxy-acetylene steel welding, bronze-welding, copper welding, pressure-welding, silver brazing, and other joining techniques . . . whether manually applied or mechanized . . . all have a place in the mass construction of equipment of many sizes and kinds.

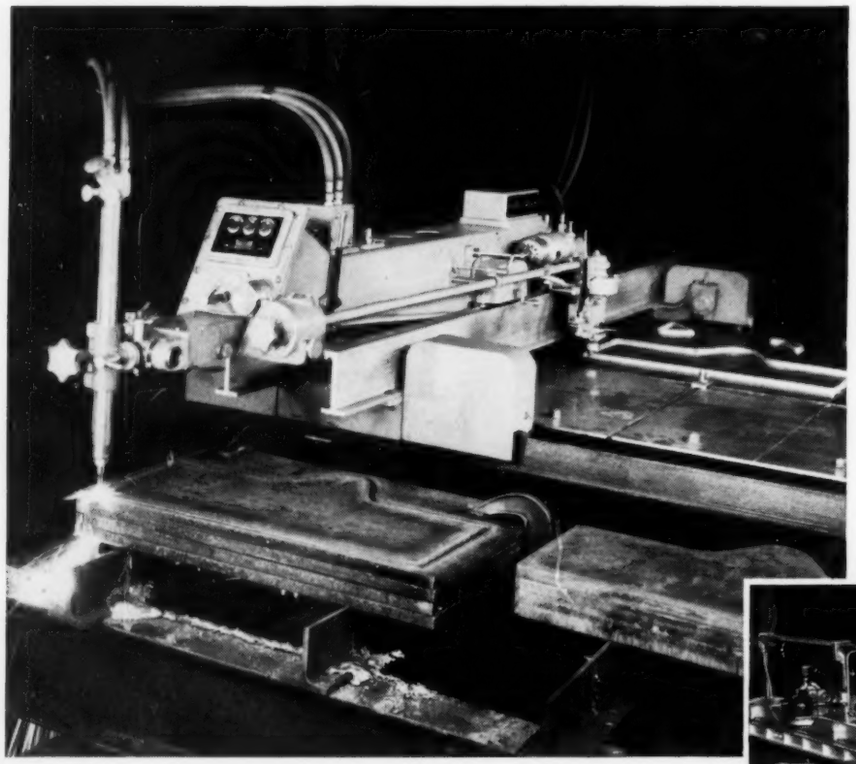
Mass production is truly a job of "carpentry in steel." Metals must be cut to size and shape . . . bent . . . formed . . . treated . . . for final fabrication. In all of these operations, Linde-developed flame processes are importantly employed.

Some applications of these flame processes are shown in the following pages. Review of them suggests the importance of keeping posted on *all* of Linde's advances in oxy-acetylene flame-fabrication . . . and of using productively, without waste, all supplies for these efficient metalworking methods.

In the Fabrication of STEEL EQUIPMENT

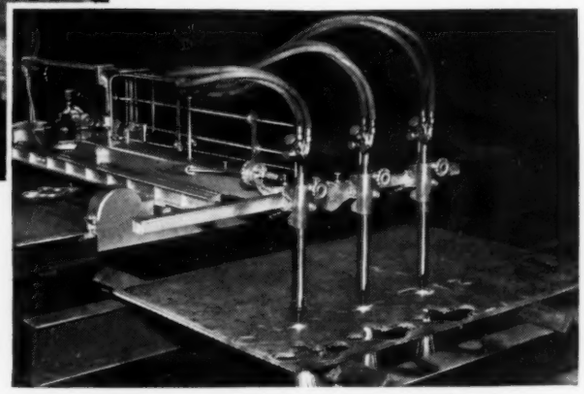
Linde Methods save Time, Power, and Materials . . .

A large part of the specialized mass production work of today is done faster, better, and at less cost by oxy-acetylene flame-techniques such as those shown here. The engineering facilities of The Linde Air Products Company helped industry to adapt these peacetime developments in efficient metalworking for today's needs. This quick review will help you to remember them . . . for tomorrow.

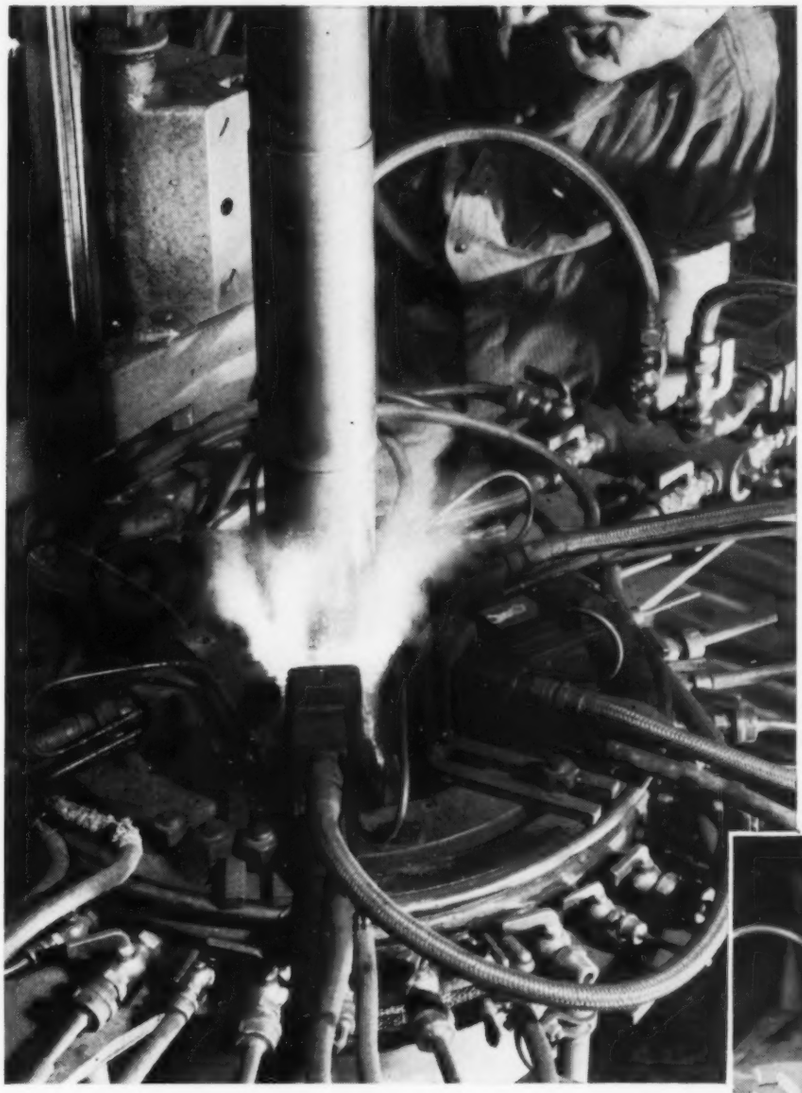


Oxy-Acetylene Flame-Cutting is a quick, "one-pass" method for shaping steel . . . in straight lines, circles, or irregular contours. Flame-cut edges are clean and smooth . . . often require no machining before use. Flame-cutting is done both with manually operated blowpipes, and with stationary or portable cutting machines. By flame-cutting, one-of-a-kind orders are easy to make up . . . design changes are simplified . . . and change-overs from parts of one shape to another require only a few minutes. In the illustration above, an Oxweld flame-cutting machine is "stack-cutting" four parts simultaneously. Shown at the right are other applications of flame-cutting.

Bending (above) — Oxy-acetylene flames provide intense, controlled heat for bending operations. Above, a pipe is being "wrinkle-bent" to produce a smooth, long-sweep turn without internal obstruction to flow.

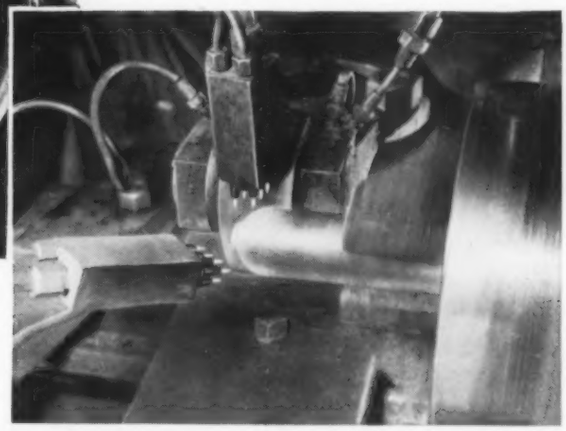


Multiple-Cutting—In some cases, when it is desired to produce numerous identical parts, several blowpipes . . . guided by a single templet . . . are mounted on the flame-cutting machine to cut simultaneously.

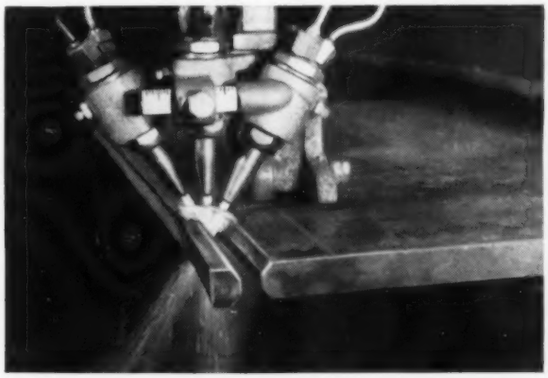


Flame-Priming (above)—Oxy-acetylene flame-priming of steel prior to painting removes loose scale, rust, moisture, oil, and grease. Paint applied to the still-warm surface bonds tighter and dries faster.

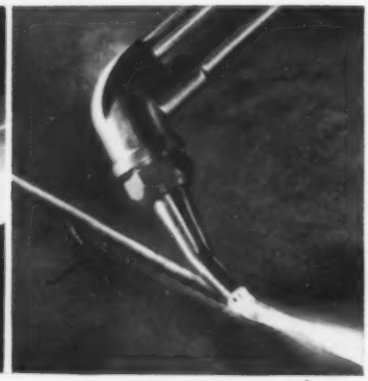
Flame-Spinning (below) — This flame-method for forming steel is used for such work as end-closure of tubing to eliminate deep-drawing operations.



Flame-Hardening (above)—Oxy-acetylene flame-hardening imparts a hard case to steel and iron parts without affecting the toughness of the core. Parts can thus be made of less costly base metals selected for core properties, and then protected against wear by flame-hardening surface areas.

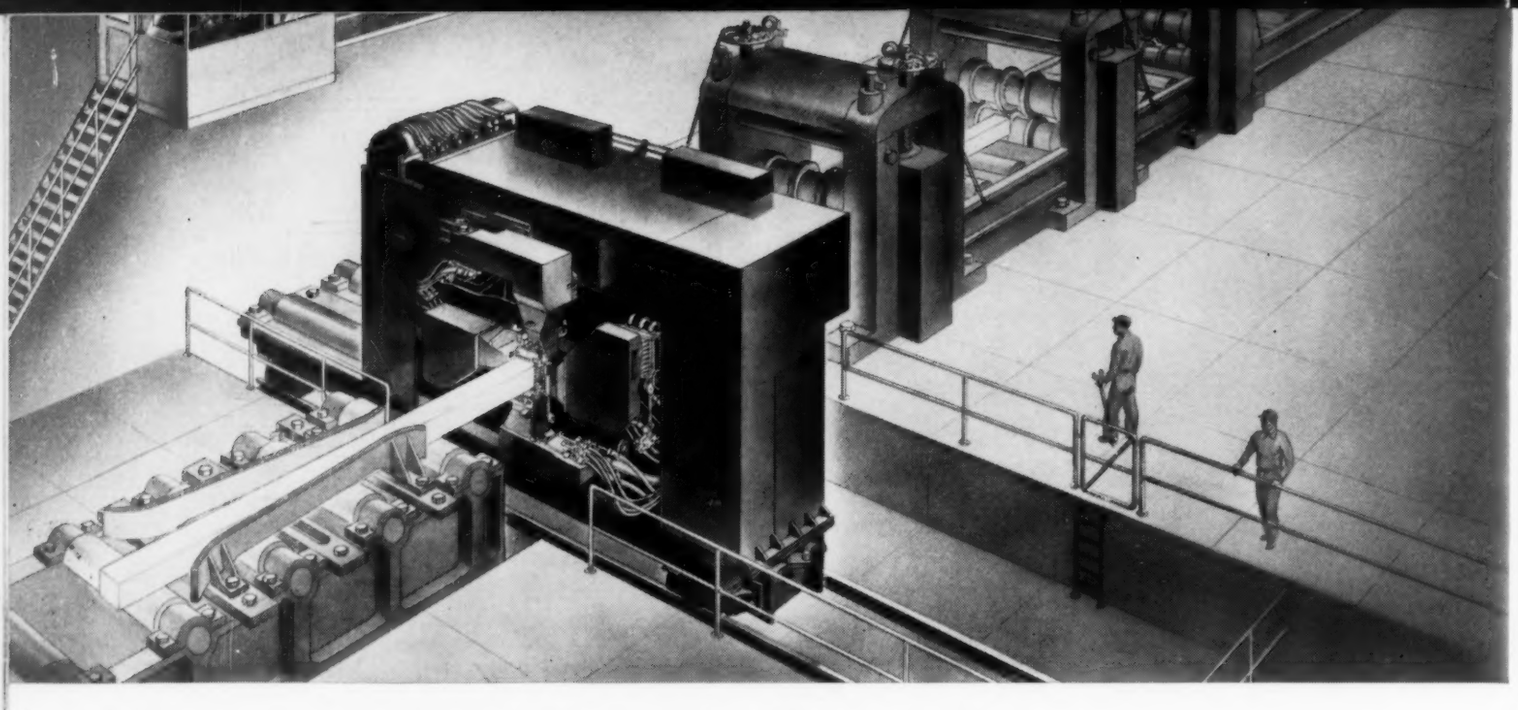


Flame-Planing—Mechanized flame-cutting in several planes simultaneously is a quick and economical way to prepare plate edges for welding. Accuracy of the cuts is comparable to results obtained by using more costly, mechanical methods.



Hand-Operated Cutting Blowpipes (above) are useful for many jobs. When used with gouging nozzles (above, right), a groove can be made quickly in a metal surface.

For more information on Linde methods, please turn the page.



MECHANIZED FLAME-SCARFING ...*helps produce* BETTER STEEL...*faster!*

Mechanized oxy-acetylene flame-scarfing of semi-finished steel is an important engineering development of The Linde Air Products Company . . . important to both the steelmaker and the fabricator because it helps to produce better steel . . . faster!

Through use of Linde-developed oxy-acetylene scarfing machines like that shown here . . . installed right in the steel mill production line . . . faulty surfaces are "skinned" from the hot steel as it rolls through . . . and a higher yield of quality steel is obtained without interruption of production.

For some special steels, such as armor plate slabs, surface removal is accomplished after the steel has cooled . . . partially or completely . . . and been removed from the roll table. This is done by Linde machines that move along the slab. Where mechanized conditioning of steel is not feasible, or for secondary conditioning, oxy-acetylene deseaming is done quickly and economically with Linde's manually operated scarfing equipment.

This BOOKLET *will tell you more about Linde* METALWORKING METHODS

The booklet shown here will be of interest . . . and may suggest new applications . . . to design engineers, to production and maintenance men, to oxy-acetylene process supervisors, and to welding foremen. It describes Linde's oxy-acetylene metalworking methods, and shows the catalogs that you can obtain to aid in your selection of the apparatus and supplies needed for applying these processes. As many copies as you require will be sent without cost by any Linde sales office.

MARITIME "M" AWARD
FOR OUTSTANDING
PRODUCTION ACHIEVEMENT

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

The words "Linde" and "Unionmelt" are trade-marks.

★ BUY UNITED STATES WAR BONDS AND STAMPS ★

For convenience and economy of transformer installations indoors near the load centers

Ask for Askarel

Pennsylvania's noninflammable, non-explosive, liquid-filled transformer

Check these outstanding qualities of Pennsylvania Askarel Transformers:

3000 kva, ASKAREL, 3 phase, 25 cycles.

✔ Circular Coils Possess Maximum Inherent Strength

In regular oil-cooled transformers, varnish is used to increase the mechanical and electrical strength of the transformer coils, irrespective of the shape of the coils. This kind of varnish, however, cannot be used to treat coils in a transformer where noninflammable liquids are employed. Therefore, without the aid of this varnish, it is imperative that the coils in a noninflammable transformer have great inherent strength. Pennsylvania circular coils possess the maximum inherent mechanical and electrical strength!

✔ Radiators Built to Withstand High Pressures

Askarel transformers develop high pressures inside the tank because of the sealed, pressure-tight, tank construction necessary to prevent loss of Askarel through evaporation. Sturdy Uni-Row radiators on Pennsylvania Askarel transformers are designed to meet these high pressures. As rugged as the tanks themselves, these radiators are premanently welded in position and tested at 100 lbs. pressure. Radiators are spaced around the tanks so that each tube of each radiator is easily sandblasted, cleaned and painted.

✔ Self-Reclosing Safety Valve Relieves Excessive Pressures.

Safety valves are mounted on the covers of all Askarel transformers above 25 kva, and operate in case abnormal pressures exceeding 12 pounds per square inch develop inside the tanks. These safety valves are self-reclosing to prevent foreign matter from entering the transformers.

333 kva, ASKAREL, 1 phase, 60 cycles.

25 kva, ASKAREL, 1 phase, 60 cycles.

Pennsylvania TRANSFORMER COMPANY
PITTSBURGH, PENNSYLVANIA

Pennsylvania TRANSFORMERS

- Since Askarel Transformers are noninflammable and nonexplosive, they may be installed indoors at the load centers without a vault or fire door.
- Since Askarel is nonsludging and nonoxidizing, and the transformer tanks are pressure-tight and moisture-proof, Askarel transformers may be installed outdoors as well as indoors.

88 TIMKEN BEARINGS

in this WEAN strip handling equipment

Be ready for post-war competition with better machines containing more Timken Bearings. Redesign now.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

SHOWN in the photograph is a Wean Heavy-duty Shearing Line with equipment for handling strip in coil form.

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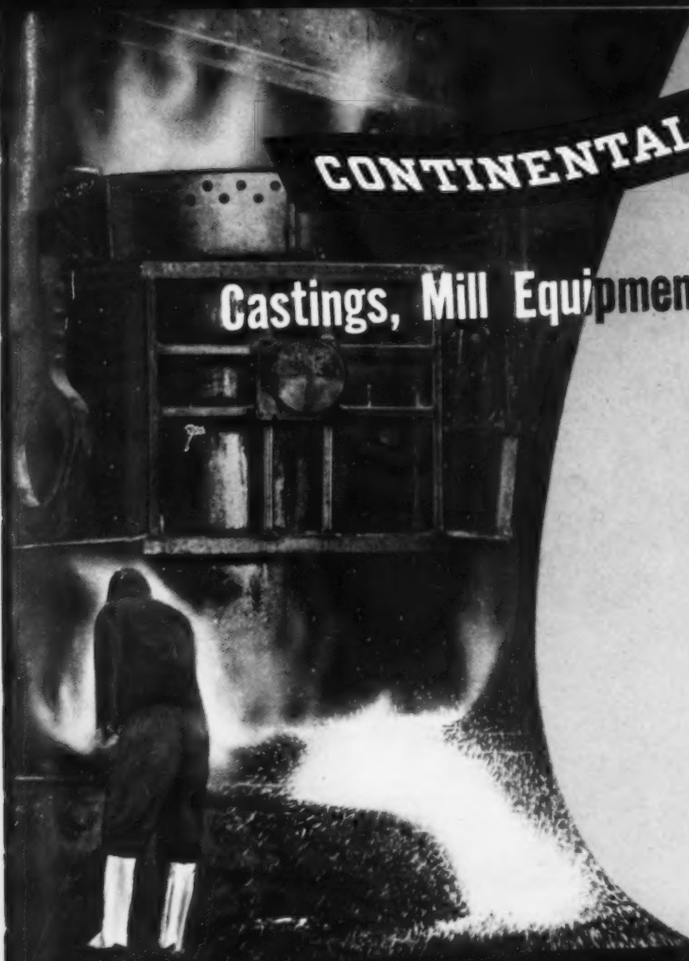
Timken Bearings have a remarkable record of accomplishment in the steel industry in all kinds of equipment. On mill roll necks for example they have rolled greater tonnages than any other roll neck bearings—and at the lowest bearing cost per ton rolled ever known. The Timken Roller Bearing Company, Canton, Ohio.



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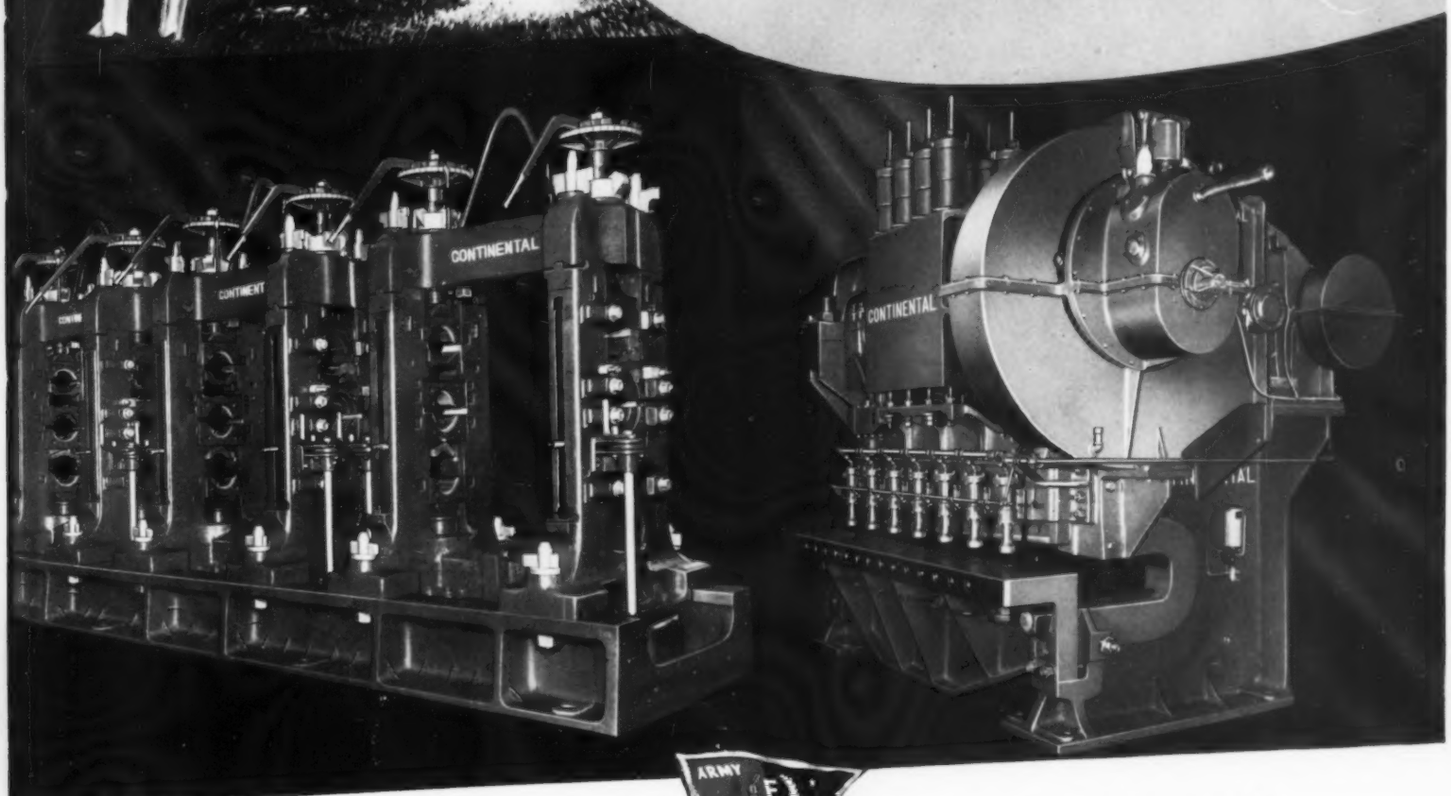
More and more mill operators are using Continental, for at Continental they find ready answers to all their production problems. Continental Roll and Steel Foundry Company • Chicago • Pittsburgh.



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MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

WITH this first issue of 1944, The Iron and Steel Engineer, as you have no doubt already observed, assumes a new size. The reduction, which is dictated by requirements for paper conservation and is obtained merely by reducing the marginal space, may be charged to the exigencies of the war. We hope it's not for long.

▲

RECENTLY come to hand is a pass dated June 24th, 1890, to the Homestead Steel Works of Carnegie, Phipps and Company, Limited. Printed on the back is the following: "No one will be permitted, under any circumstances, to divert from his duties the attention of any employe. Canvassers, solicitors, peddlers or others defying this notice will be subject to ejectment from the premises." Pickin' on the peddlers again, huh?

▲

THE Allied high command counted sixty bombing planes and hundreds of young American flyers well spent in order to cripple a portion of Germany's bearing production capacity. Over one hundred thousand alleged Americans, probably every one having a more or less personal stake in the war, contributed to the crippling of their own production by breaking their own no-strike pledge in order to force their own wilful desire down the throats of their own government — and they got away with it.

▲

AND then there's the railroad situation — the managements of the roads and all but three unions agreed to arbitrate, with no strike. But three unions still wanted to strike, so the government must take over the railroads from the management, who had agreed to the arbitration. Why not take over the three recalcitrant unions? That'll be the day!

▲

LOOKING to the time when the closed shop might be general and a union composed of routine technicians might swallow the professional engineer, willy-nilly, the American Society of Civil Engineers, oldest engineering society in the United States, has formally approved a plan to set up a collective bargaining agency for professional engineers. Whether such means will be effective against exclusive bargaining contracts remains to be seen — or will we have jurisdictional strikes between the engineers and the unions? Maybe we should have taken law.

PERSONALLY, we don't blame that "high government official" for venting his ire, anonymously or otherwise, about the affects of strikes upon our common (we hope) enemies. With the 1943 record of strikes many times worse than the 1942 record, it's time we all added our two cents worth to swell the refrain into an overwhelming chorus of disapproval, regardless of the writhings of labor leaders, instead of demanding investigation about "whodunit."

▲

WITH the third revision of the Code of Wartime Practices for the American Press, the Office of Censorship continues its sensible handling of the situation by materially relaxing many restrictions. Certainly, our overall production figures offer no solace to the enemy, and it is a pleasure to work with an agency that uses a realistic attitude in such matters.

▲

IRON ore production in the United States in 1943 is estimated at 113,554,000 net tons, a decrease of 4 per cent from the record total of 118,189,336 tons in 1942. Decreases occurred in the lake region and the southeastern states, while the northeastern states and western states showed increased production.

▲

ADD to the other weird by-products of the times — steel employes refusing to attend training courses leading to supervisory jobs because seniority would be the basis of promotion, anyway.

▲

IT is with regret that we note a growing reluctance, mounting even into a phobia, on the part of the American people to "sticking their necks out." There is probably not one development or advance in the history of humanity that did not entail someone "sticking his neck out." Leonardo da Vinci's sketches of flying machines no doubt encountered much ribald hilarity. Fun was poked at the idea of sending messages without wires, or, for that matter, over wires. The horseless carriage, electric mill drives, wide strip mills — the list is endless — each one was a venture into the unknown. Yet we, allegedly the most progressive people in the world, are beginning to be afraid to "stick our necks out." If this is a result of our growing collectivism, we need some more good, rugged individualists.

▲

A REPORT from England tells of difficulties in direct rolling of some lend-lease ingots into plates. The difficulty was encountered only on one ingot out of every 15 or 20. Investigation showed that the troublesome ingots were top-poured, among the bottom-poured majority. Just shows that we don't always know which end is up.

▲

THE February issue of Iron and Steel Engineer will carry a comprehensive survey of "The Modern Arc Furnace." Prepared with the cooperation and collaboration of the Electric Metal Makers Guild, Inc., this material will be reprinted for distribution through the electric furnace industry.

▲

REMEMBER when, at Christmas time, you might find a bottle in your stocking instead of stockings in a bottle?

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Regardless of the shapes you specialize in, you'll find that Pittsburgh Rolls do the work more accurately at less cost per hour—or per year. The reason? They're made by a company manufacturing one product only — Rolls for Rolling Mills.

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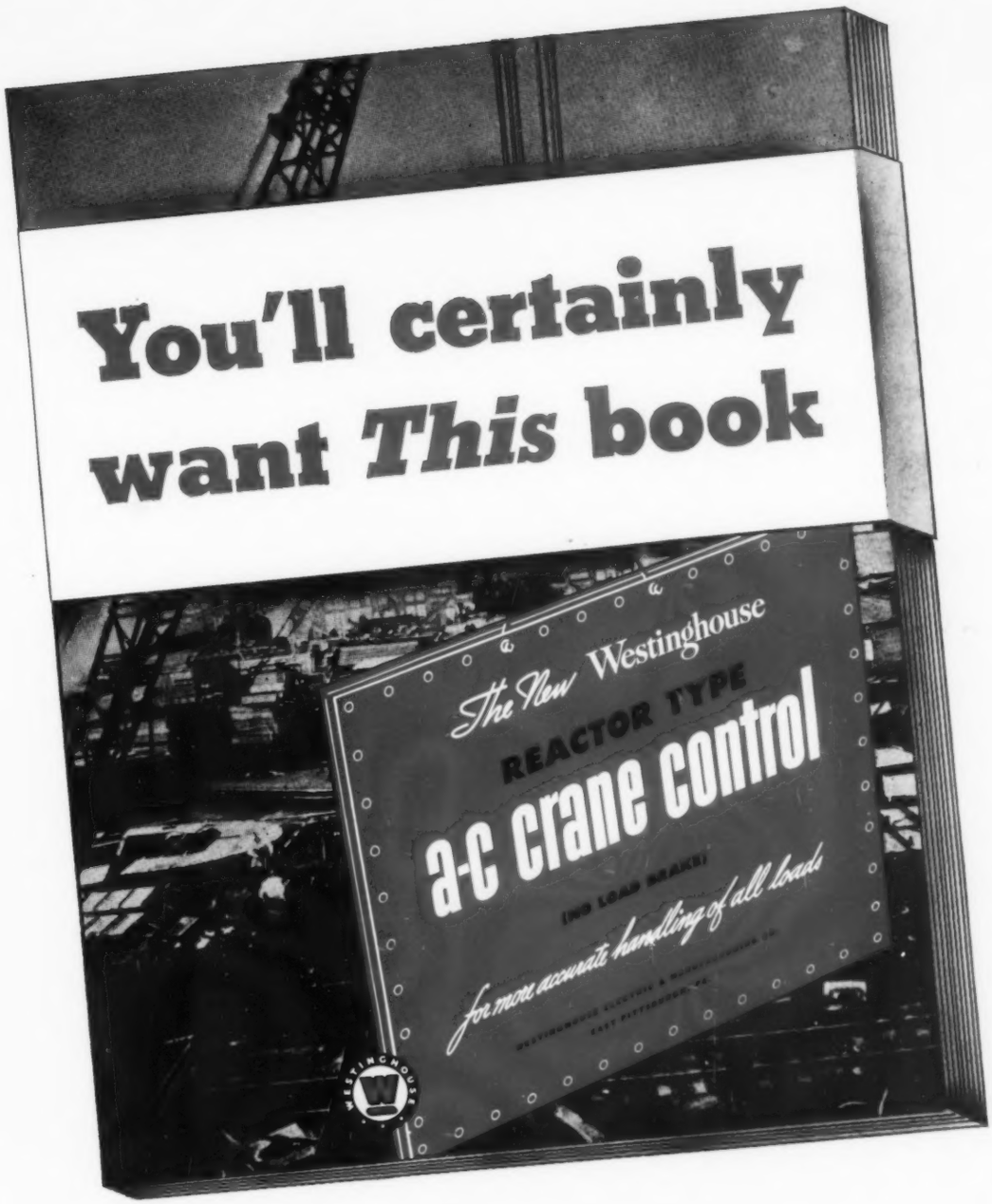

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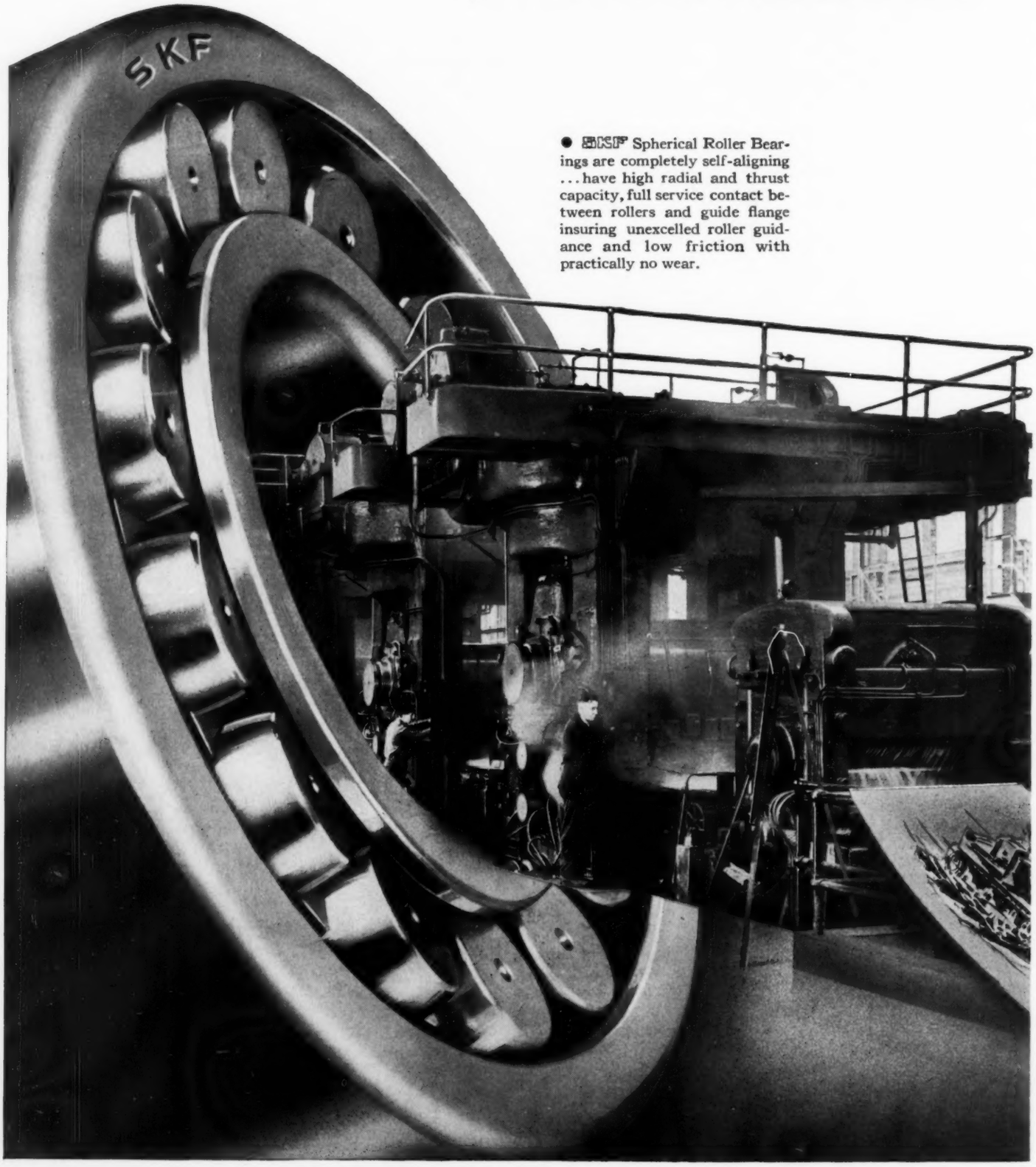

● SKF Spherical Roller Bearings are completely self-aligning ... have high radial and thrust capacity, full service contact between rollers and guide flange insuring unexcelled roller guidance and low friction with practically no wear.

IS KNOCKING 'EM OUT

No matter how large the force in the field, it would be helpless against the armed might of the Axis if it didn't have the proper tools—and *plenty* of them. Likewise, the huge rolling mills that produce materials from which these tools are made would be helpless under war's load and speed requirements without reliable antifriction bearings. SKF Bearings are on vital turning parts throughout the Steel Industry. 5453

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Iron AND Steel ENGINEER

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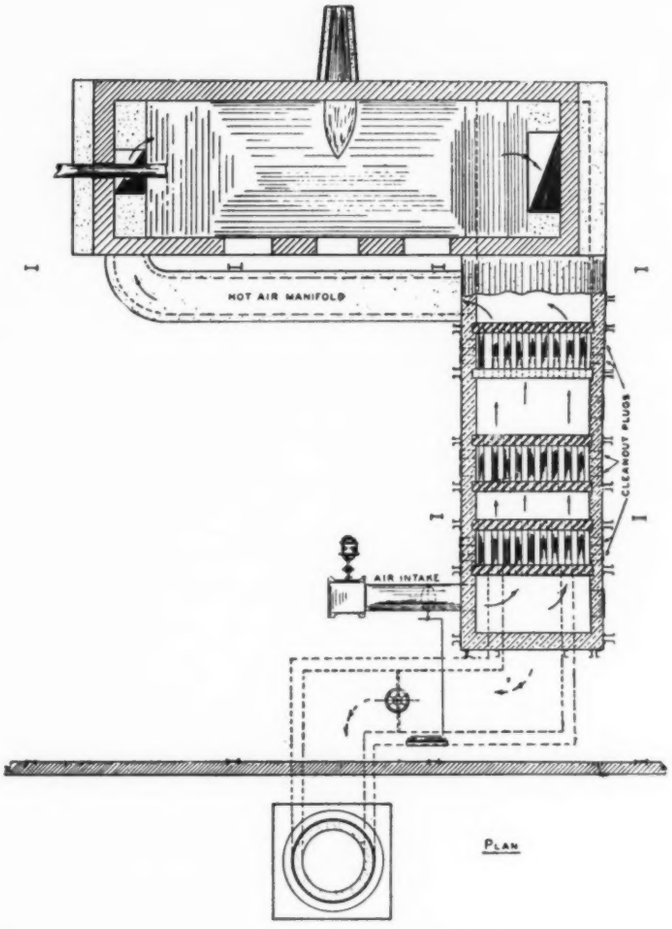
The design illustrated shows a standard small capacity regenerative open hearth furnace converted to a non-reversing recuperative furnace.



The "Fitch" silicon carbide tubular heat transfer elements will withstand any temperature or chemical reaction found in open hearth practice. Their life is greater than any known material used for this work.

The life of the "Fitch" recuperator as a whole is prolonged over an indefinite period of time by the ability to replace individual parts without disturbing the balance of the structure. Cost of replacements, per ton of steel poured, is negligible.

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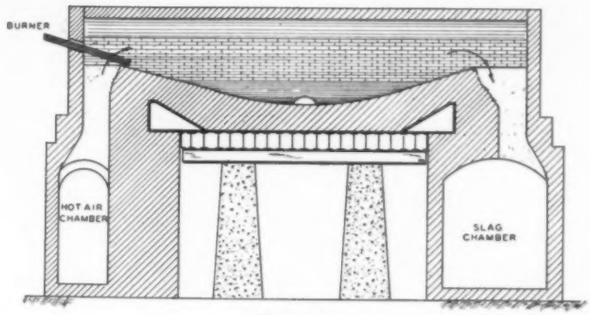
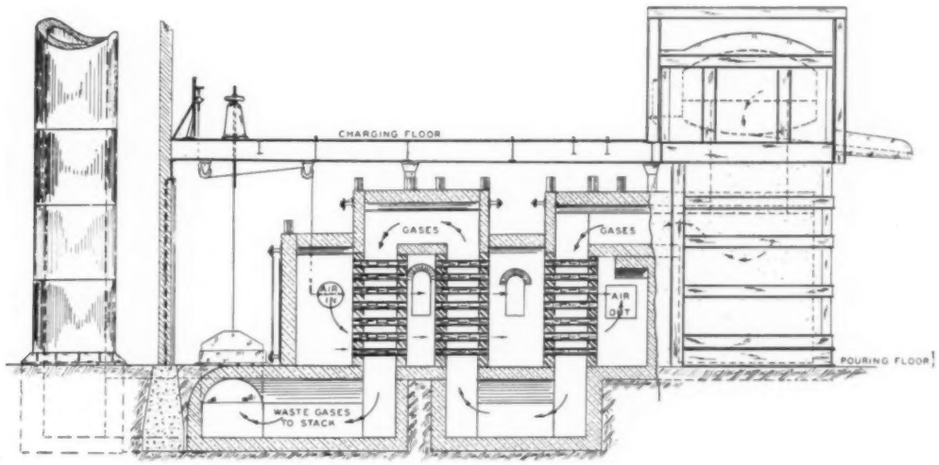


ELEVATION

The furnace design is not changed other than the remodeling of one slag chamber to form the hot air uptake.

The existing hot air port from the slag pocket level to the burner remains unchanged, utilizing the heat in the furnace brickwork to further increase the temperature of the air leaving the recuperator.



ELEVATION & SECTION

The air for combustion enters the furnace with the fuel in the conventional manner. Air passages cannot clog up as they are used for the passage of air only.

Firing continuously in one direction is ideal for control by instruments.

Write for Bulletin No. 12

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ARMY NAVY

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SOME OBSERVATIONS ON *Plate Mills*

. . . . the article describes the new plate mill of Kaiser Company, Inc., at Fontana, California, and offers some practical plate mill operating suggestions . . . .

by W. A. White

SUPERINTENDENT OF ROLLING

KAISER COMPANY, INC.

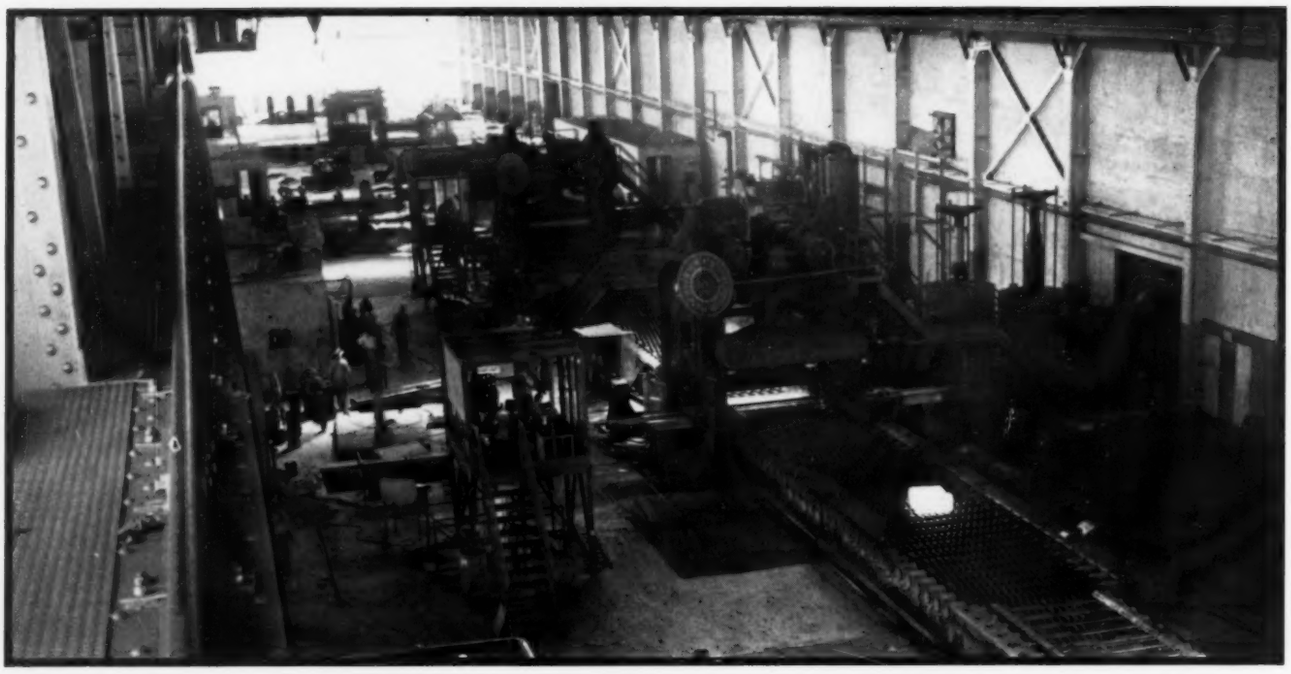
FONTANA, CALIFORNIA

▲ THE heavy demand for plate products in the war program has brought the plate mill into a prominence it has not enjoyed for many years. These demands far exceeded the country's mill capacity commonly thought of as plate capacity and required the conversion of many of the modern continuous wide strip mills to plate production. This conversion, which really required only the addition of heavier shearing and leveling equipment, and perhaps additional cooling tables, was carried out with speed and dispatch, and the fine results are well known. The continuous and semi-continuous strip and plate mills have been well described in many publications of this Association, and need not be discussed here except to say that they are the last word in rolling large quantities of light plate material. They involve a heavy initial investment, and to some extent, lack flexibility for small orders of various sizes of material. It was perhaps the tremendous size and capacity of these units, and the dramatic suddenness of their development, that crowded the previously existing plate mills into temporary oblivion. It remained for the war to focus interest sharply upon all types of plate mills.

Sheared plate mills are, for the greater part of the three-high type, with the middle roll of a diameter approximately two-thirds that of the top and bottom rolls. This design makes for a simplified drive, not requiring reversing equipment, but necessitating the use of tilting tables. The four-high reversing mill will produce a more uniform gauge than will the three-high mill, because of the added stiffness afforded by the backup rolls. A 110 in. four-high single-stand reversing mill recently built in Canada produces plates ranging $\frac{3}{16}$-6 in. thick with an average rolling rate of 40 net tons per hour.

There is still a very definite place in the steel industry for the single stand plate mill — preferably the four-high unit with vertical edging rolls on the entering side. A unit of this type makes a very flexible mill for plate, as it is able to roll any width and any gauge at any time.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943



General view of the Kaiser plate mill from entry end.

It is also a very good breakdown or roughing mill to precede the finishing stands of a strip or light plate mill.

It has been definitely established that a 110 in. four-high mill using work rolls with a diameter of 36 in. or over, and backup rolls of 48 in. diameter and over, can be operated using straight work rolls for the first 5000 tons of average plate orders before it becomes necessary to crown the work rolls. The next 5000 tons will require a .010 in. crown in the top roll only, and the following 10,000 tons a .010 in. crown in both the top and bottom work rolls. It has been found desirable to change back-up rolls after 20,000 tons, and start over.

It is the writer's opinion that, wherever possible, it is best to break down the slab or ingot at a speed of 250-300 fpm until the plate is about 10 ft in length, when the speed should be increased to 400-450 fpm until the plate is finished. The slow speed at the start of roughing keeps the steel tracking in the center of the mill and prevents the breakdown from becoming out-of-square, with consequent loss of yield.

It is not particularly advantageous to roll plates in exceptionally long lengths. The best results seem to be obtained up to about 40 ft.

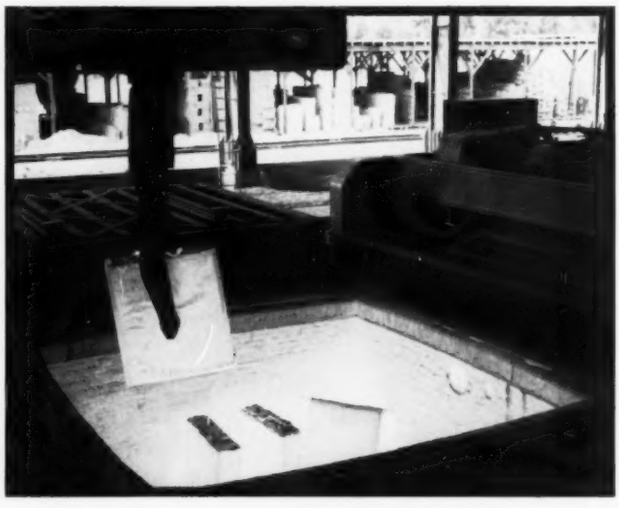
The draft should be about 30 per cent in each pass down to the last two finishing passes, which should be left to the judgment of the roller in order to deliver a flat plate. The draft of the next-to-last pass is generally 10-15 per cent, and the last pass is then backed off to a draft of about .040 in.

The single stand mill, whether two-, three-, or four-high, has the objection that the same rolls are used for both roughing and finishing. Better plate surface quality may be attained by separating these operations. Thus, we have the two-stand tandem mill coming into the picture, a unit particularly adapted to the thinner gauges and capable of greater tonnages than the single stand mill.

As an example of recent plate mill design, we might take the sheared plate mill just put into operation at the Fontana, California, plant of Kaiser Company, Inc. This is a 110 in. two-stand tandem mill consisting of a two-high roughing stand and a three-high finishing stand with the necessary tables, shears, and levelers. The mill is designed to roll plates ranging from $\frac{3}{16}$ in. to $1\frac{1}{2}$ in. in thickness, up to 96 in. wide, at a rate of 45-60 tons per hour.

The mill is rolling directly from ingots ranging from 12 in. to 24 in. in thickness. Heating equipment at present consists of twelve pit furnaces, 13 ft, 6 in. long

Twelve pit furnaces, fired with coke oven gas, heat ingots for rolling into plate at the Fontana plant of Kaiser Company, Inc.

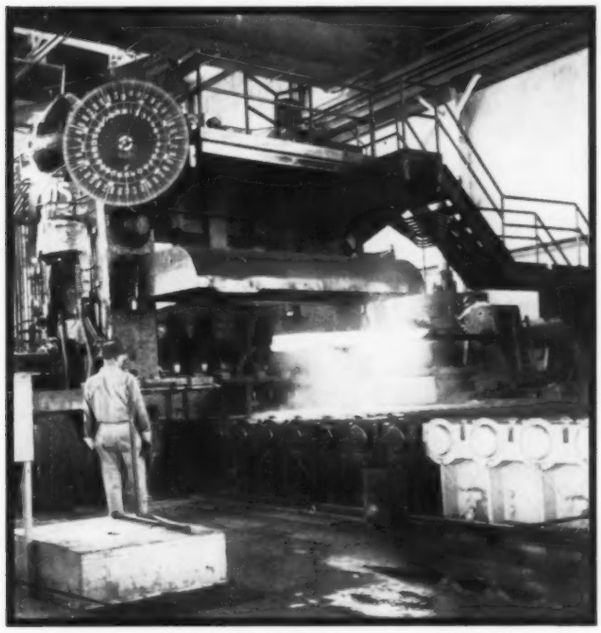


x 13 ft, 6 in. wide, and fired with coke oven gas through a single large burner located in the center of the hearth. Air for combustion is preheated in refractory recuperators, and the pits are equipped with automatic controls for temperature, furnace pressure, and gas-air ratio. Space has been allowed in the plate mill layout for two continuous furnaces to be installed in the future if desired.

The pit furnaces are placed in a row at right angles to the 90 ft x 550 ft plate mill building, and a tilting ingot car brings the ingots to the mill tables.

Four table sections, 28-38 ft long, are driven at a speed of 360 fpm through line shafts by 50 and 75 hp motors, one drive to each table. A fifth table section, 23 ft, 4 in. long, and driven at 350-700 fpm by a 100 hp motor, serves as an entry table to the vertical edging rolls, and works in conjunction with the entry and delivery tables of the roughing stand.

From the ingot buggy track to the vertical edging stand is a distance of about 173 ft. Edger rolls, 44 in. in diameter x 30 in. in length and operating in roller bearings, are driven by a single 1500 hp, 750 volt, 80-240 rpm reversing motor, and may be adjusted to give a



Close-up of two-high reversing roughing stand, which is driven by two 3500 hp motors in a twin drive.

clearance between rolls up to 110 in., the adjustment being actuated by two 50 hp motors. Feed and delivery rolls to this unit are driven by two 15 hp motors.

Located 27 ft, 5½ in. beyond the edger is the two-high roughing or slabbing stand, a 44 in. x 112 in. unit operating at speeds of 345-855 fpm. A 7000 hp twin-motor drive operates this mill, with a 3500 hp, 750 volt, 30-75 rpm reversing motor connected directly to each roll. A maximum roll lift of 31 in. may be had in this stand, the movement being made by mill screws 16 in. in diameter, of 1½ in. pitch, and driven by two 100 hp mill type motors. Side guards on this mill are driven by 25 hp motors, and feed and delivery rolls by 35 hp motors.

On each side of the two-high stand are tables 13 ft, 4 in. long, each driven at 350-700 fpm by a 75 hp motor. A turn-table mechanism is installed in each of these tables so that broadside rolling may be done to increase ingot width.

One hundred feet beyond the roughing stand is a three-high, 26½ in. and 40 in. x 110 in. finishing stand, driven by a 7000 hp, 750 volt, 50-120 rpm d-c motor, at speeds of 350-840 fpm. Maximum roll opening in this unit is 14 in., and the screw down mechanism is similar

The three-high finishing stand, located 100 ft from the roughing train is driven by a 7000 hp, 750 volt variable speed d-c motor.

to that on the roughing stand, except that it operates under variable voltage control. This stand is designed to resist a maximum separating force of 9,600,000 lb, and the housing posts are 28 in. x 31 in. in a horizontal sectional plane.

Mill spindles 12 ft long x 22 in. in diameter connect the rolls to a three-high pinion stand using double helical pinions of 6.187 in. circular pitch and 70 in. face. Top and bottom pinions are 47¼ in. in diameter, with 24 teeth, the middle pinion, 31½ in. with 16 teeth.

On each side of the finishing stand is a 32 ft, 5 in. tilting table driven at speeds up to 500 fpm by two 100 hp motors operating under variable voltage control. The tables are tilted through articulated levers actuated by two 150 hp mill type motors. The application of motor-operated side guards on these tilting tables represents a unique design, which is useful in holding the plate in the center of the mill.

Each mill stand is operated from a pulpit placed along the side of the mill line, and slightly toward the entry side of the stand.

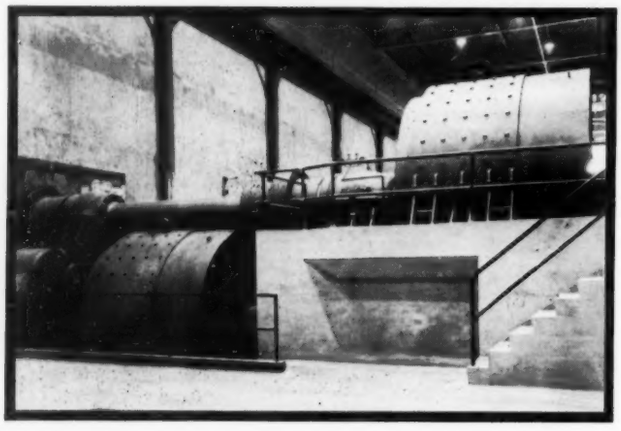
Roll necks of the two-high roughing stand run in tapered oil-film bearings, while composition bearings are applied to the three-high unit. In the former case, circulating oil systems provide lubrication, while water and grease are used on the three-high mill.

Hydraulic water at 500 psi pressure operates the two-high roll balance, and a 510 psi oil-hydraulic system

After leaving the finishing stand, plate material passes through this light plate leveler, located in the hot mill runout. ↑

View showing end of cooling table run, with castor bed and side shears. →

Twin drive motors on the reversing roughing stand are housed in the motor room, together with other main drives, motor-generator sets and control equipment. ↓



is used on the three-high stand. In the latter mill, the middle roll is shifted by oil-hydraulic power at 1400 psi.

Descaling is accomplished by hydraulic sprays of 1200 psi pressure. Two centrifugal pumps of 600 gpm capacity supply sprays which are located at the two-high stand, top and bottom of the forward entry side, and at the three-high stand on the bottom of the forward entering side and on the top of the back pass. A motor-operated roll changing rig is provided at each of the two mill stands. Steel rolls are used in the two-high roughing stand, with grain iron in the three-high finisher.

Beyond the finishing stand, the mill tables extend for a distance of about 286 ft. In this line are located a dividing shear and a light roller leveler, the latter operating at speeds of 152-455 fpm. Immediately following the leveler a chain and dog type transfer and cooling bed 75 ft long and with a speed of 140 fpm carries the plates to parallel table lines located in an adjacent building bay. This bay is 100 ft wide and 1100 ft long and contains two parallel cooling tables, the first 65 ft from the mill line and the second table, 30 ft from the first. Disc-type rollers are used extensively in these cooling runs. The first table contains a heavy roller leveler and a rotary side-trimming shear. The second line contains an end shear, shear gauge, inspection turn-up and scale table, and is in line with a castor bed containing two side shears. These tables operate at 100-300 fpm, except immediately before and after the rotary side shear, where the speed is 50-150 fpm.

Unloading skids are located at various points along this table so as to facilitate handling insofar as possible.

Beyond the end of the cooling tables, the building provides space for plate storage and shipping, and plans call for the future addition of an adjacent building, 100 ft x 650 ft, for storage and shipping purposes.

The motor room is a 65 ft bay extending along the mill building for a distance of 375 ft. Here are located the three main drives, as well as their control equipment and motor generator sets. The twin-drive on the roughing stand and the edger drive are served by a flywheel motor generator set consisting of two 3000 kw and one 1250 kw, 750 volt d-c generators. Another set, with two 3000 kw generators, serves the finishing stand drive. Each of these motor generator sets is controlled by a slip regulator. Main and auxiliary exciter sets are provided as required by the drive control systems, as well as two motor generator sets for variable voltage operation of the front and back tables of the rougher, and for the screwdown, and front and back tables of the finishing stand. Two 1000 kw motor generator sets supply 230 volt d-c power for mill auxiliaries.

Power is brought to the motor room at 6900 volts, which is the operating voltage of the large units.

A-c auxiliaries operate on 440 volt power, supplied by two load distribution centers in the motor room, each provided with a 6900/480 volt transformer. All switchgear is of the metal-clad type.

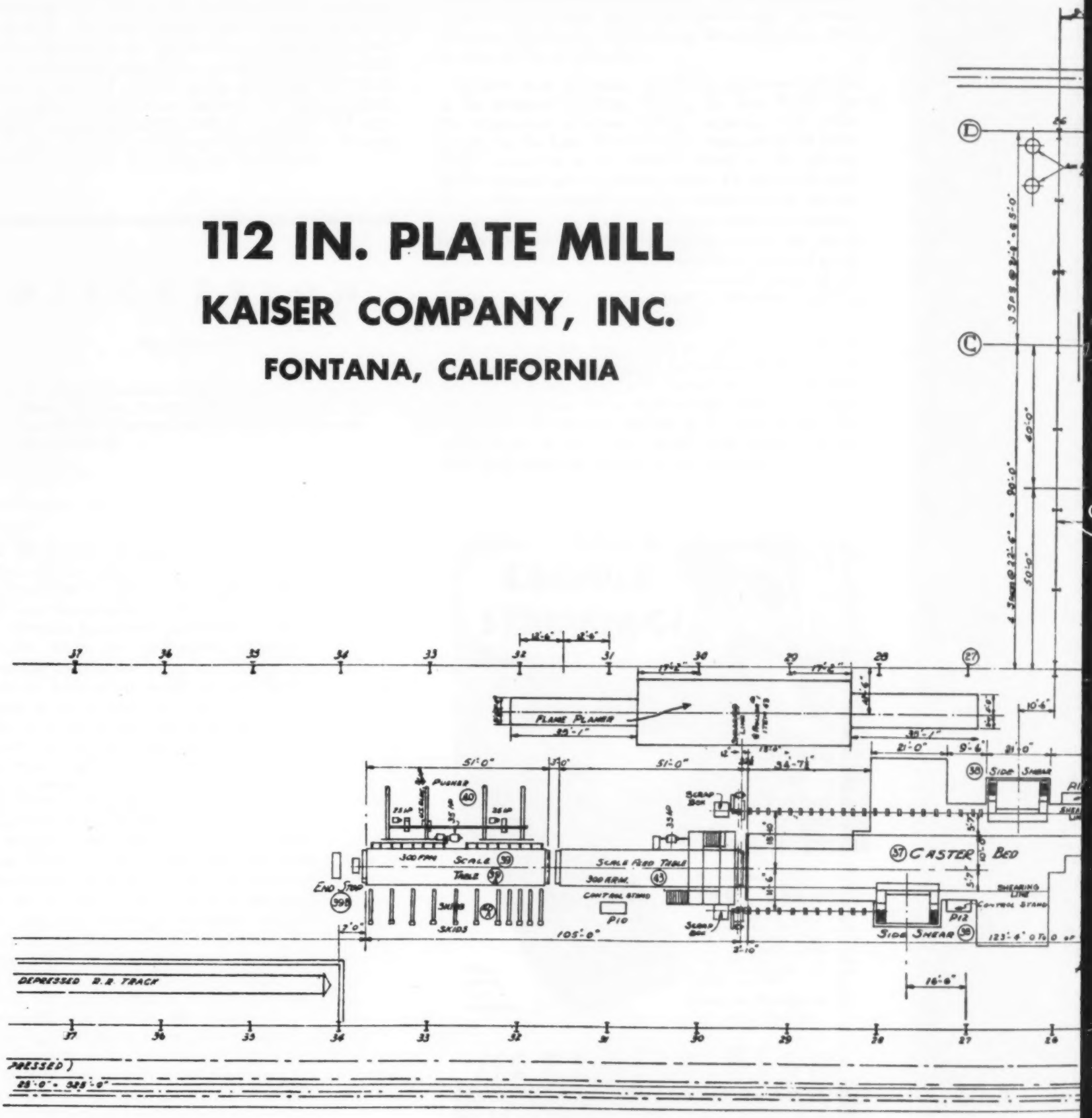
The entire motor room and the rotating machinery contained therein are ventilated by a recirculating system whereby cooled air is forced up into the room, and down through the machines, through cooling units, and back into the motor room.

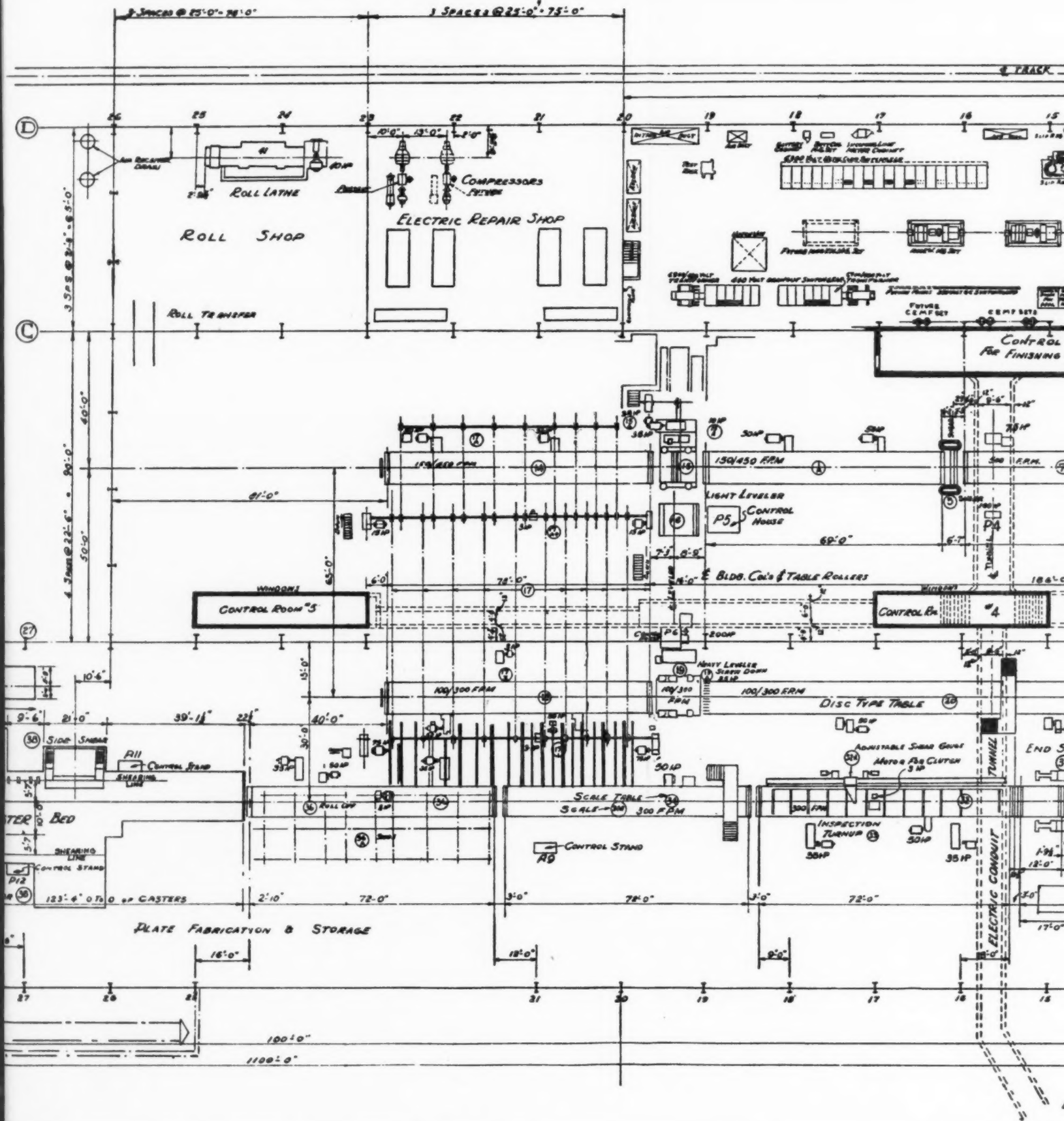
At the end of the motor room bay is an electrical

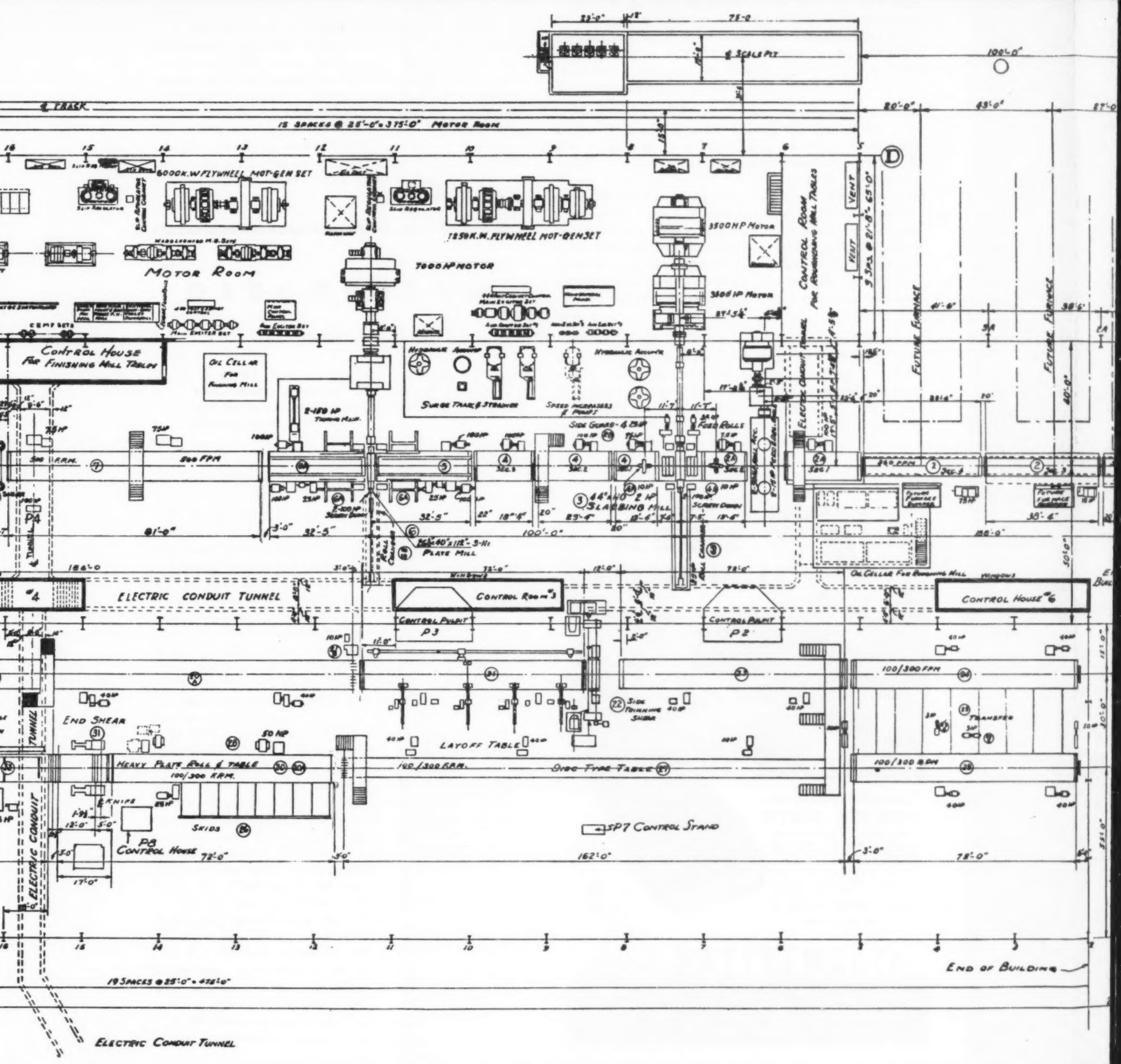
112 IN. PLATE MILL

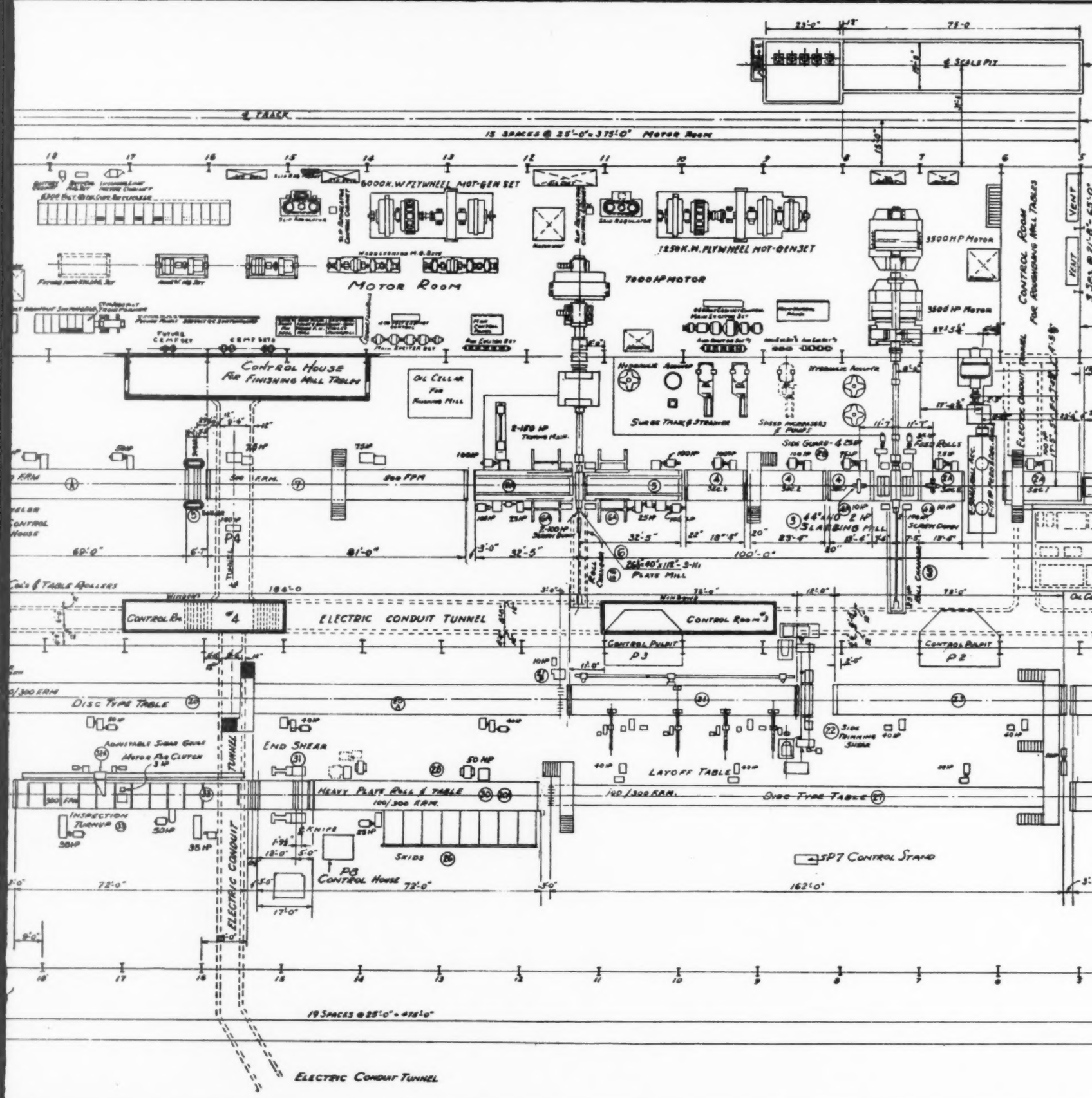
KAISER COMPANY, INC.

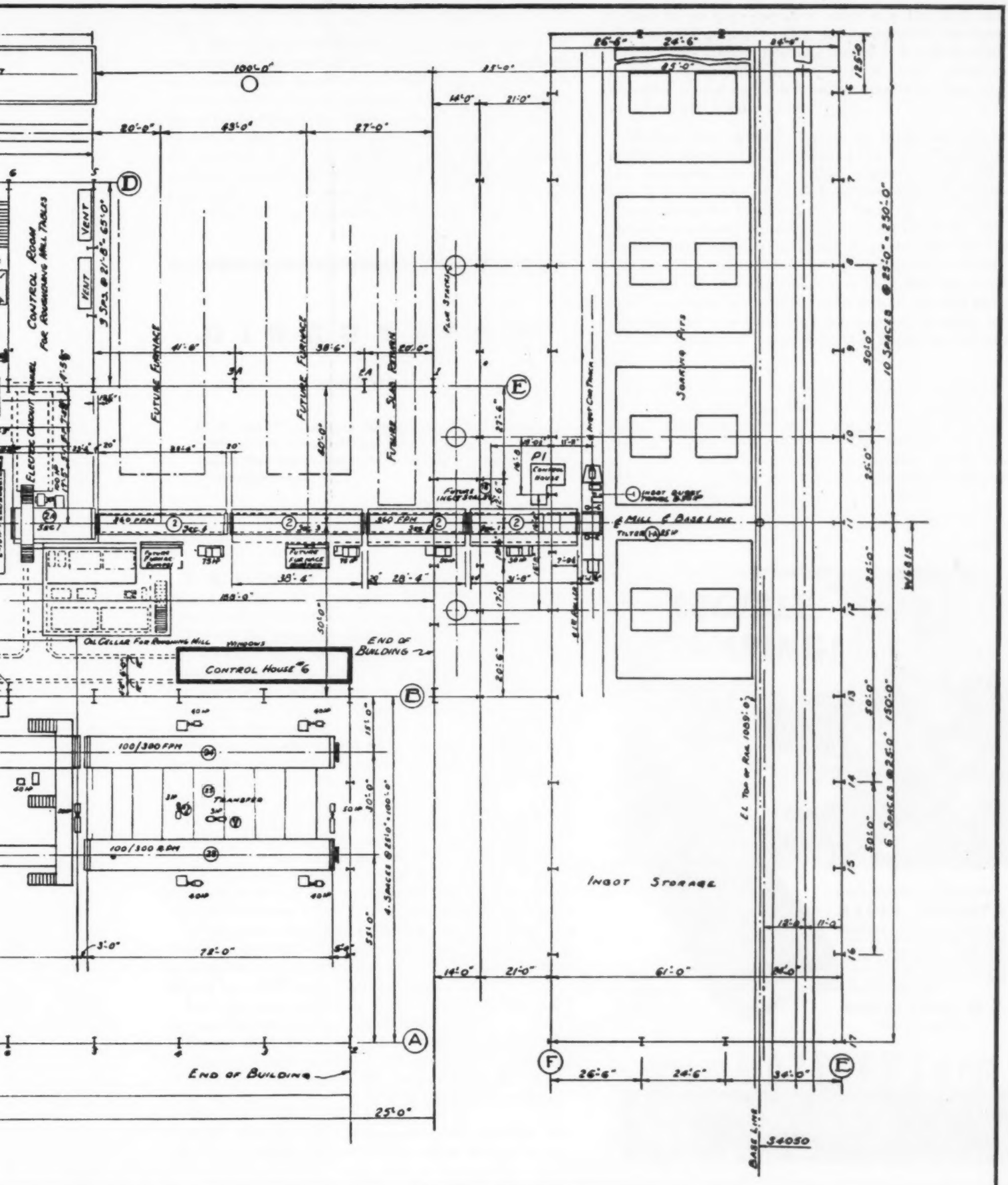
FONTANA, CALIFORNIA




ROLL SHOP
ELECTRIC REPAIR SHOP
ROLL LATHE
COMPRESSORS
ROLL TRAVELER
CONTROL ROOM "5"
CONTROL ROOM "4"
CONTROL FOR FINISHING
LIGHT LEVELER
CONTROL HOUSE
P5
P4
P6
P12
BLDG. Co's & TABLE ROLLERS
130/450 F.P.M.
100/300 F.P.M.
DISC TYPE TABLE
SCALE TABLE
300 F.P.M.
INSPECTION TURNUP
ADJUSTABLE SHEAR GAUGE
SIDE SHEAR
SHEARING LINE
CONTROL STAND
123'-4" C to C of CASTERS
PLATE FABRICATION & STORAGE
ELECTRIC CONDUIT
TUNNEL
100'-0"
1100'-0"


℄ TRACK
15 SPACES @ 25'-0" = 375'-0" MOTOR ROOM
6000 K.W. FLYWHEEL MOT-GEN SET
7850 K.W. FLYWHEEL MOT-GEN SET
MOTOR ROOM
7000 HP MOTOR
3500 HP Motor
3500 HP Motor
CONTROL ROOM FOR ROUGHING MILL TABLES
VENT
VENT
3 SPS. @ 21'-8" = 65'-0"
FUTURE FURNACE
FUTURE FURNACE
CONTROL HOUSE FOR FINISHING MILL TABLES
OIL CELLAR FOR ROUGHING MILL
HYDRAULIC ACCUM.
HYDRAULIC ACCUM.
SURGE TANK & STRAINER
SPEED INCREASERS & PUMPS
SIDE GUARD - 4 15HP
FEED ROLLS
2-450 HP Tilting Mach.
500 F.P.M.
500 FPM
2-100 HP Screw Down
44" AND 2 HP SLABBING MILL
SCREW DOWN
100'-0"
81'-9"
32'-5"
22'
18'-4"
20'
83'-4"
20"
18'-6"
7'-5"
18'-6"
39'-6"
80'-0"
100'-0"
40'-0"
50'-0"
186'-0"
72'-0"
12'-0"
72'-6"
#4
ELECTRIC CONDUIT TUNNEL
CONTROL ROOM #3
CONTROL PULPIT P3
CONTROL PULPIT P2
OIL CELLAR FOR ROUGHING MILL
WINDOWS
CONTROL HOUSE #6
100/300 FPM
END SHEAR
LAYOFF TABLE
SIDE TRIMMING SHEAR
TRANSFER
HEAVY PLATE ROLL & TABLE
100/300 R.P.M.
SIDE TABLE
100/300 R.P.M.
100/300 R.P.M.
KNIFE
SKIDS
P8 CONTROL HOUSE
72'-0"
50'
162'-0"
3'-0"
78'-0"
SP7 CONTROL STAND
ELECTRIC CONDUIT TUNNEL
19 SPACES @ 25'-0" = 475'-0"
END OF BUILDING
ELECTRIC CONDUIT TUNNEL


18 SPACES @ 25'-0" = 375'-0" MOTOR ROOM
MOTOR ROOM
6000 K.W. FLYWHEEL MOT-GEN SET
7250 K.W. FLYWHEEL MOT-GEN SET
7000 HP MOTOR
3500 HP Motor
3500 HP Motor
CONTROL HOUSE FOR FINISHING MILL TABLES
OIL CELLAR FOR FINISHING MILL
CONTROL ROOM FOR ROUGHING MILL TABLES
ELECTRIC CONDUIT TUNNEL
CONTROL ROOM #4
CONTROL ROOM #3
CONTROL PULPIT P3
CONTROL PULPIT P2
DISC TYPE TABLE
END SHEAR
HEAVY PLATE ROLL & TABLE
LAYOFF TABLE
DISC TYPE TABLE
SKIDS
SP7 CONTROL STAND
PG CONTROL HOUSE
ELECTRIC CONDUIT
TUNNEL
19 SPACES @ 25'-0" = 475'-0"
ELECTRIC CONDUIT TUNNEL


CONTROL HOUSE #6
INGOT STORAGE
SOAKING PITS
FUTURE FURNACE
FUTURE SLAB REHEAT
MILL & BASE LINE
END OF BUILDING
100/300 FPM
TRANSFER
VENT
P1
34050

repair shop, 65 ft x 75 ft, which also contains an air compressor. A roll shop and roll storage, 75 ft x 155 ft, runs across the end of the motor room and mill building bays.

A development in finishing equipment worthy of mentioning was used in the Canadian mill previously mentioned. The plate leveler was designed with hydraulic cylinders under the screws controlling the opening of the leveling rolls. These cylinders act as a cushion in case a plate of heavier gauge than that for which the machine is set enters the leveler. The hydraulic cushion, operating at 3000-3500 psi pressure, will compress and allow the over-gauge plate to pass through without stalling or damaging the leveler rolls.

DISCUSSION

PRESENTED BY

F. R. BURT, Industry Engineering Department, Metal Working Section, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

F. R. BURT: It might be in order to give a brief resume of the additional plate mill capacity that has been installed recently or is being installed.

During the present expansion in plate rolling capacity, six mills have been purchased in this country and Canada. Three are now rolling plate and the other three are to go into operation shortly. In addition to these six mills, what might be considered as the forerunner of the modern plate mill was installed in 1937. This is a four-stand 100 inch tandem finishing mill driven by four 5000 hp direct current motors and a four-high roughing stand driven by a 7000 hp, 40/80 rpm reversing motor.

In 1941 a 100 inch four-high reversing plate mill was installed in Canada. This mill is driven by a 5000 hp, 35/80 rpm motor, and is now used to produce finished plate. However, the layout was made with a view to future installation of a tandem finishing mill in which case the reversing mill will be used as a roughing stand.

A 140 inch four-high reversing mill was put into operation in 1942. This mill is used as a finisher for an existing three-high roughing mill. The reversing mill is driven by a 7000 hp, 35/80 rpm motor.

Just put into operation is the mill which has been thoroughly described by Mr. White.

During 1942 three other plate mills were purchased. One is a 120 inch universal mill driven by a 7000 hp, 35/80 rpm motor with a 500 hp motor on the edger. This mill also is used as a finishing stand after an existing three-high roughing mill.

A 160 inch four-high mill is now being installed and will be in operation shortly. This mill is driven by two 5000 hp, 40/80 rpm motors in twin arrangement. It is the first plate mill with twin motor drive.

Also to go into operation soon is a 132 inch mill, consisting of a scale breaker, spreading stand, reversing rougher and tandem finishing mill. The roughing stand is driven by a 7000 hp, 40/80 rpm double armature reversing motor and the finishing stands by four 5000 hp adjustable speed motors.

Modern war naturally causes an immense increase in the demand for plate. During the first World War the expansion in plate rolling capacity took place largely in the form of three-high constant speed mills. There seems to be no definite trend in the present period toward any one arrangement. Of the seven mills above, two consist of reversing roughers with tandem finishers, two consist of reversing finishers in combination with existing three-high roughers, two are single stand reversing mills rolling from slab to finished product, and one is a three-high continuously running adjustable speed mill supplied from a reversing slabbing mill.

However, all are heavy mills and all new stands, except one, are four-high. Each includes a reversing type drive, which operates at a comparatively low base speed and thus is able to deliver high torques. On none of them is the finisher limited to constant speed. The trend seems to have run toward mills which will produce large tonnages of heavier gauge plate.

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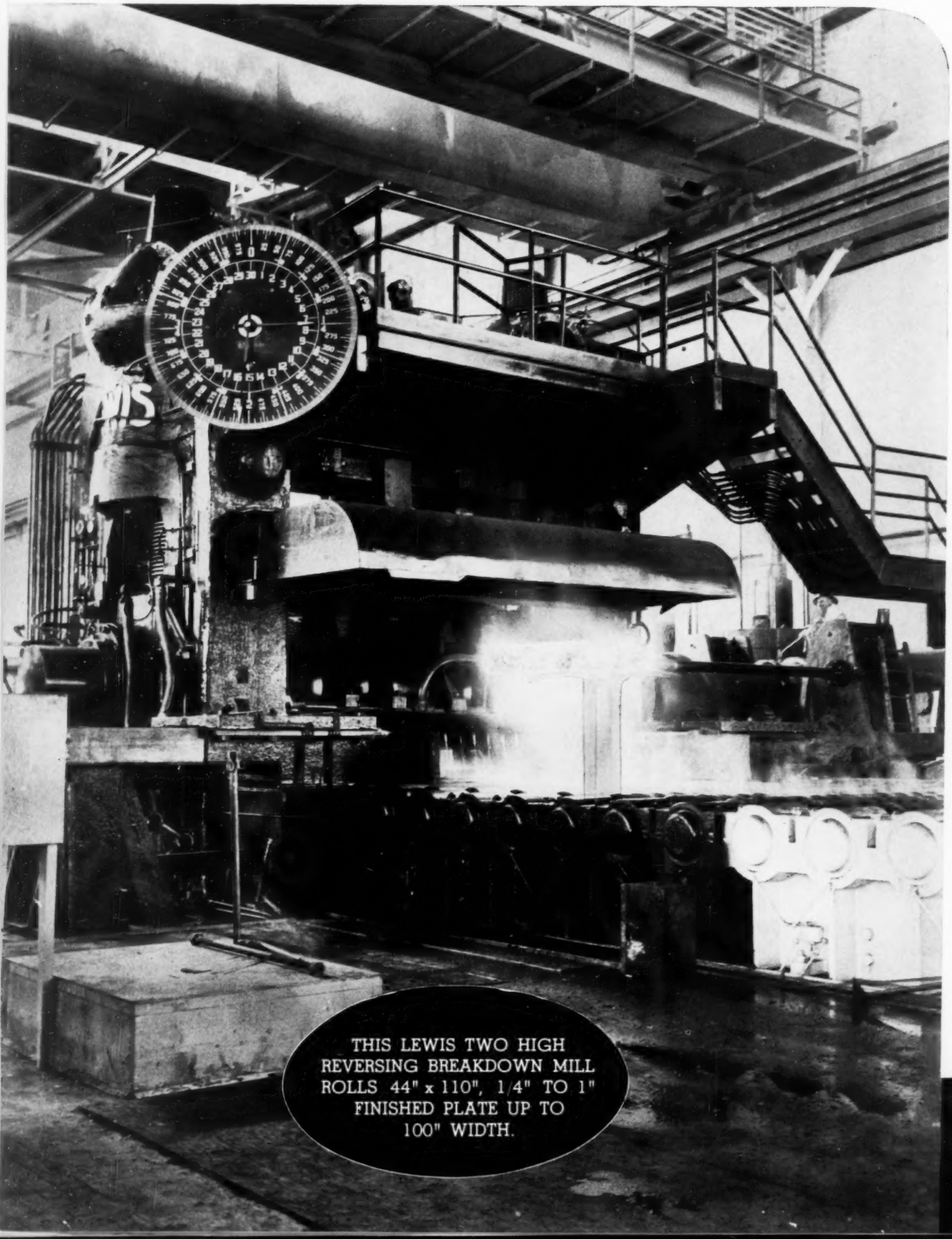


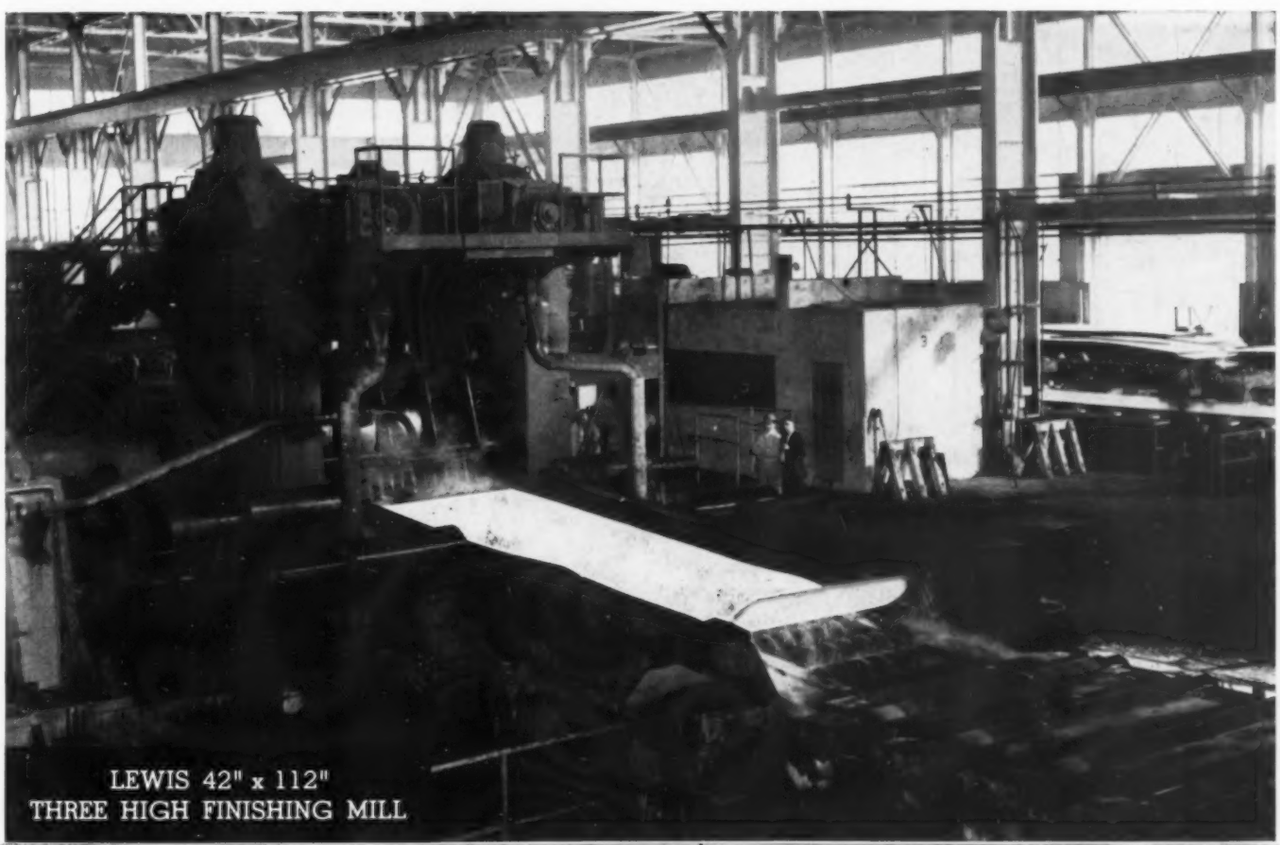
THIS LEWIS TWO HIGH REVERSING BREAKDOWN MILL ROLLS 44" x 110", 1/4" TO 1" FINISHED PLATE UP TO 100" WIDTH.

Plate Production for Victory Ships

Lewis Foundry and Machine Division is proud of this opportunity to help speed up production of Victory ships through the design and production of a complete rolling mill for ship plates in the remarkable time of fourteen months from initial design to operation.

The equipment includes: Vertical Edger, Two High Reversing Mill, Three High Finishing Mill, Ingot Buggy, Approach-Delivery and Transfer Tables, Dividing Shear, End Shears, Side Trimmer Shear, Light and Heavy Roller Levelers, Inspection Tables, Roll Lathe and Rolls.

This accomplishment is a typical example of the high quality of Lewis service which has long been recognized by operators of steel and non-ferrous rolling mills. Lewis rolls and rolling mill machinery have contributed their part to the international growth of rolled products from the very beginning.



LEWIS 42" x 112"
THREE HIGH FINISHING MILL

LEWIS

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DIVISION OF BLAW-KNOX CO.

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Progress IN SUPPLYING POWER TO *Arc Furnaces*

. . . . furnace design and skillful operation have combined with progress in electrical equipment and power supply to give electric arc furnaces an excellent production record . . . .

by C. C. Levy

INDUSTRY ENGINEERING

METAL WORKING SECTION

Westinghouse Electric & Manufacturing Company

EAST PITTSBURGH, PENNSYLVANIA

▲ THE electric steel melting industry has experienced a marked expansion in the last two years. Production of electric steel in 1943 will be nearly 5,000,000 tons. The manner in which this increase has taken place is shown in the record over a number of years of total kva capacity in furnace transformers installed per year as shown in Figure 1. It seems therefore that this is a particularly good time to review what has been accomplished in the past; and then take a look at the future to see what further developments the industry needs.

POWER SUPPLY

The logical start for this review will be the power supply. By the power supply, I mean the incoming line to the furnace transformer and the immediate power system from which the furnace feeder is supplied.

The electric arc furnace is a large single concentrated load which has a number of special characteristics. The most annoying of these characteristics from the power companies standpoint is the highly fluctuating value of kw and kva demand which accompanies the melting down of the charge. In the earlier applications of furnaces, sufficient consideration was not always given to this feature of the furnace load. As a result voltage regulation suffered on the feeder supplying the furnace as well as on other feeders connected to the same bus. The best solution to this problem is a careful analysis of the load and its effect on the existing system or on proposed future extensions of that system. The furnace manufacturers have fairly well standardized the electrical equipment for different sizes of furnaces both as regards transformer capacity, and reactance required with the transformer. It is therefore quite possible to analyze the circuits in advance and predetermine the effect of the furnace load on the system. Excellent methods of analysis have been developed by power company engineers, and when conditions are known they can furnish a power supply that is adequate and satisfactory to them from a regulation standpoint. We would recommend that proposed installations be brought to the attention of the power company engineers so that a joint study can be made and a satisfactory power supply assured when the installation is made.

Figures 2 and 3 show typical arrangements of the power supply. A single furnace with no provision for future extensions is relatively simple. However many of the early installations which operated for many years as single furnace jobs have been enlarged, and some of these may now become a problem to the power supplier. Other larger installations have been increased as much as 200 or 300 per cent over original plans. In these cases, through no fault of the original designers, problems of poor regulation in the system have arisen to plague the power companies.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943

However, special equipment and special schemes have been developed to reduce even the worst of these cases to a more satisfactory state. The principal remedial measures which can be used are as follows:

1. The use of motor generator sets.
2. The use of synchronous condensers with series reactor.
3. The use of series capacitors.
4. Segregation of furnace load.

The motor generator set is theoretically the most effective buffer device for reducing flicker due to fluctuating loads. It is clearly effective in removing from the power system all rapid single or polyphase swings in reactive kva, due to short circuits in the furnace. It will also reduce the kw swings because of the stored rotational energy in the units. The ideal arrangement would be an induction motor generator set with a flywheel, and liquid slip regulator control such as is used in large rolling mill drives, where peaks of power are absorbed by the action of the slip regulator in increasing the slip of the motor thus slowing it down and permitting the flywheel to supply the kw peak. The high initial cost of such equipment even though it is the most effective theoretically has prevented the use of motor generator sets for this purpose, except perhaps in cases where the furnace load was rather small.

Synchronous condensers have been used in a number of installations for the specific purposes of reducing lamp flicker, improving voltage regulation, and for correction of power factor. The synchronous condenser, when a sudden change takes place in its terminal voltage, will absorb instantly both kilowatts and reactive

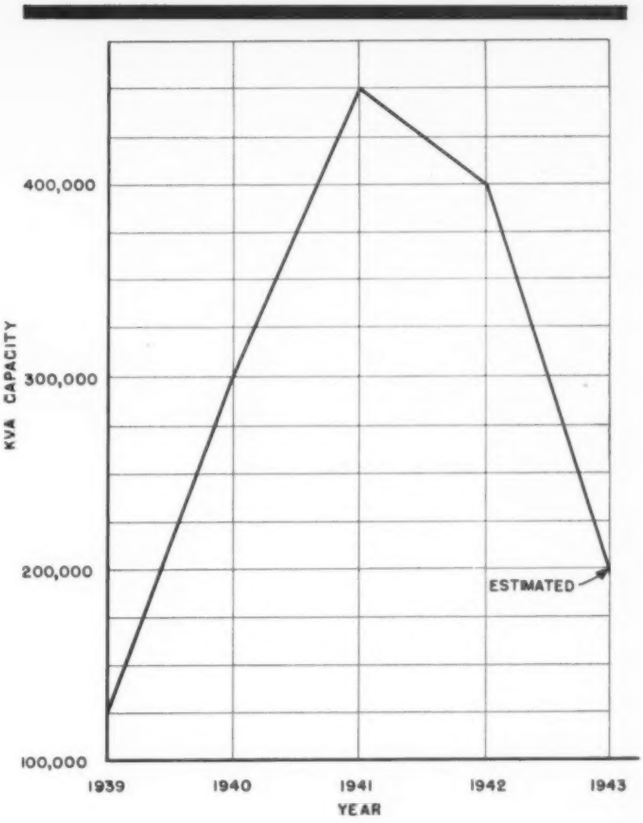


Figure 1 — Chart showing capacity for steel melting furnace transformers installed each year.

▲

Figure 2 — Typical single furnace feeder layout.

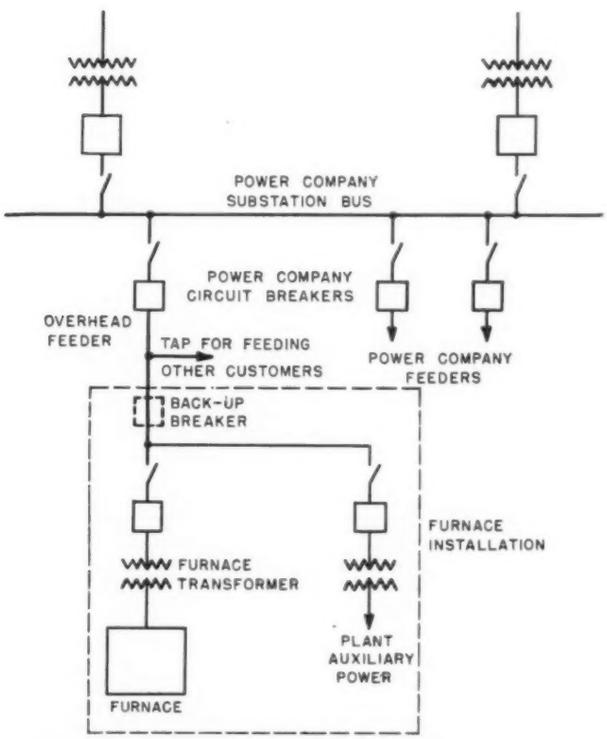
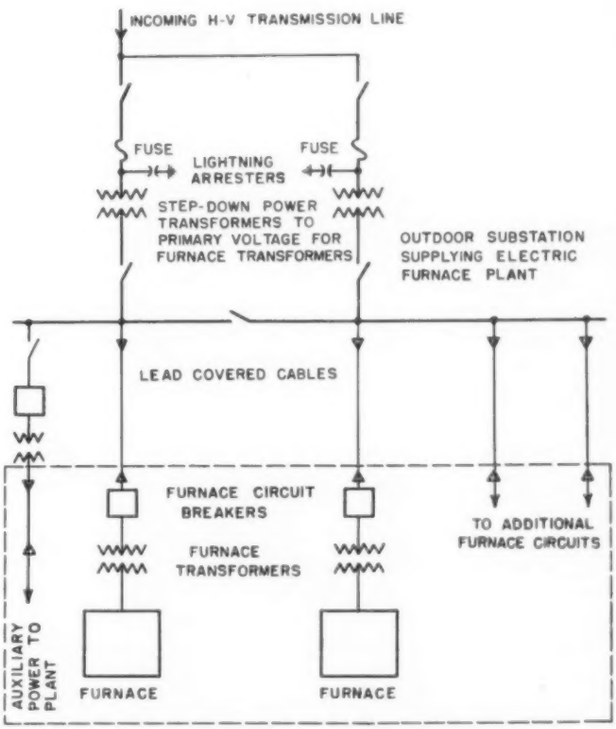


Figure 3 — Typical layout for multiple unit large scale electric furnace installation.



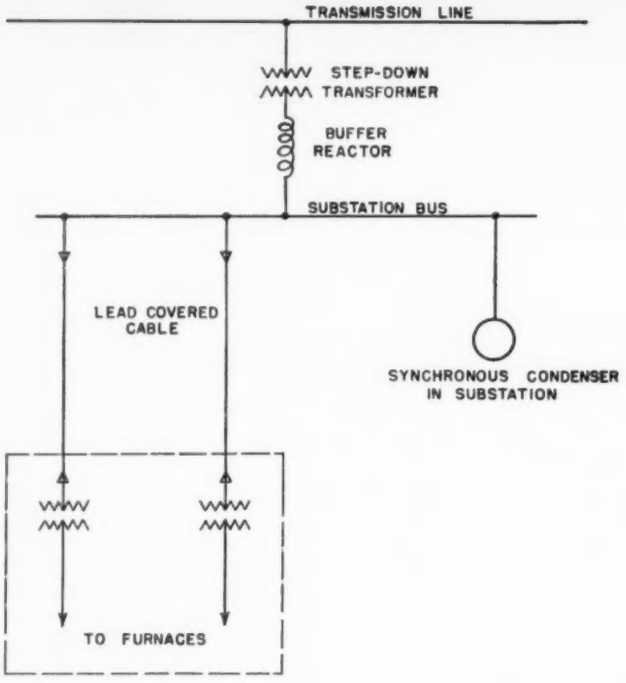


Figure 4 — Sketch showing location of buffer reactor in combination with synchronous condenser.

POWER FACTOR CORRECTION

The vastly increased demands on power systems in the last two years, has naturally focused attention on the need for improving the power factor of electric arc furnaces. The average power factor of the furnace load depends on

1. The size of the furnace.
2. The amount of reactance used for small and medium sized furnaces.
3. The method of operation.

The large furnaces requiring 10,000 up to 15,000 kva transformer capacity do not operate at much better than 85 per cent power factor even under the most favorable conditions. The reactance of the secondary leads is the principal limitation. In this matter of lead reactance considerable improvement can be made by special bus designs using interlaced leads, but there is a limit beyond which improvement is not practical. In addition to this it sometimes happens that furnaces are operated at values of secondary current which are far too high for the operating voltage being used. In some cases the power factor is reduced to the point where a simple test will show increase in kw input by merely reducing the secondary current. Ideal operation combines a high melting rate with a high average power factor. This can only be accomplished by careful atten-

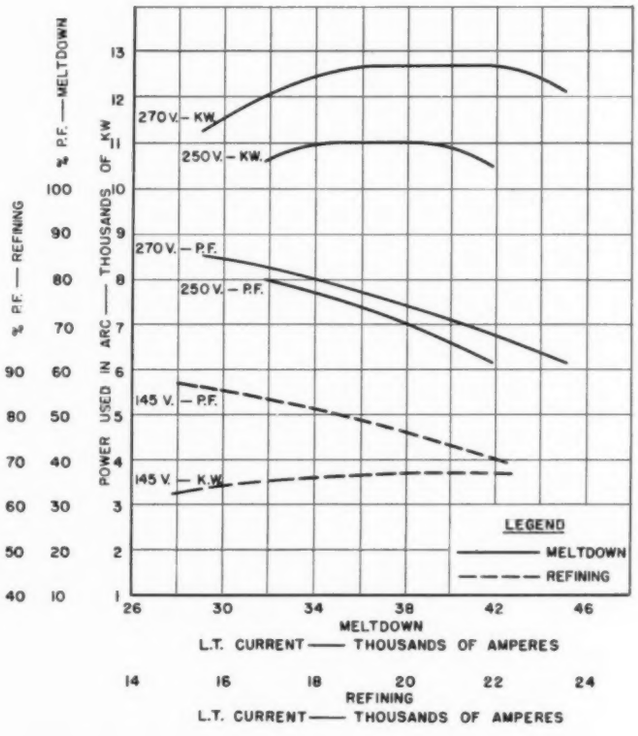
kva thus reducing voltage fluctuations on the distribution system. The addition of a buffer reactor as shown in Figure 4 improves this performance, by increasing the reactance between the furnace bus and the power system.

Because of the additional advantage obtained in power factor correction by the use of a synchronous condenser, it is of all methods the most attractive and has been applied to great advantage in several large furnace installations.

The series capacitor has frequently been considered as a remedy for voltage flicker, because its instantaneous corrective effect automatically adjusts itself to changes in load current. Its chief drawback is the difficulty in applying it to existing systems and transformers. The ohms of the capacitor should be about equal to the total reactance of the furnace transformer and the secondary leads. However it is somewhat difficult to fix the maximum current under short circuit conditions, which will determine the current rating of the capacitor. Because of the application difficulties — the series capacitor has not been adopted as a remedy for voltage flicker due to arc furnace operation.

The fourth remedy for fluctuating loads is to put several furnace loads on one feeder from the power substation. This feeder is then supplied from a separate bus in the substation which is connected to an independent transformer bank. In this way the effect of the furnace load swings on the lighting distribution buses is considerably minimized. This is an excellent solution to the voltage flicker problem, but one which relatively few power companies are in a position to employ.

Figure 5 — Curves giving variation of kw in the arc and power factor of the circuit with varying low-tension current on a given operating tap.



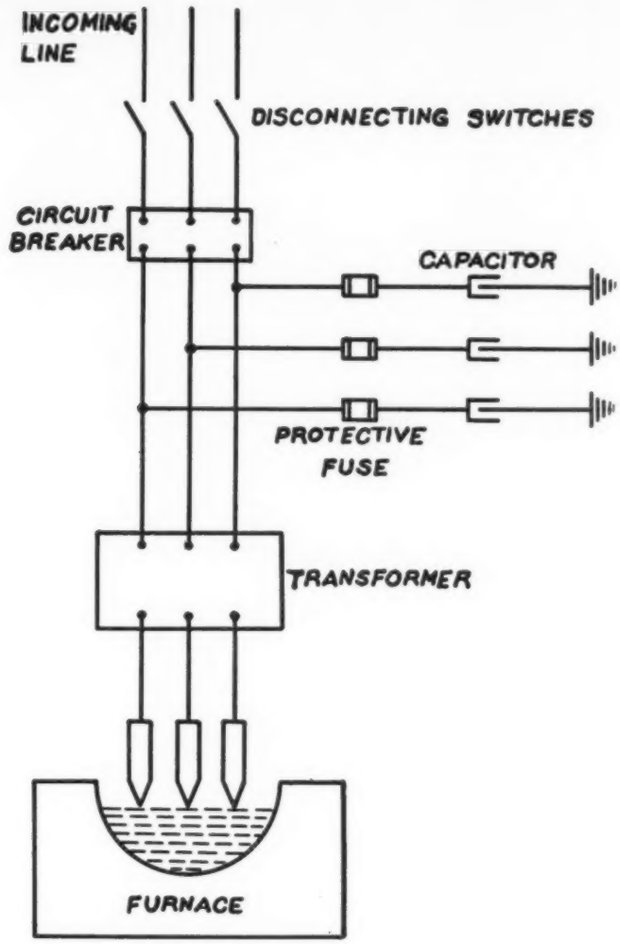


Figure 6 — Sketch of connection of surge protective equipment on arc furnaces.

tion and use of the operating voltages and currents to insure that the power factor is a maximum for the desired kw input. The charts in Figure 5 illustrate this quite clearly. The curve of kw input to the furnace does not vary a great deal in the zone from 80 to 65 per cent power factor, but it is obvious that if we operate at a secondary current that gives us 65 per cent power factor, we certainly are operating inefficiently when we can get 80 per cent power factor with practically the same kw input to the furnace. In addition to the current adjustment we can when possible, increase voltage and decrease current and obtain a decided improvement in average power factor.

Even though the refining operation in any one furnace takes a great deal less reactive kva than the meltdown operation, that is no reason why the power factor should be neglected in this part of the heat. However some plants pay little attention to this, and carry very much higher secondary currents than the refining voltage tap warrants. Where there are many furnaces, the aggregate reactive kva due to this cause will certainly bring down the average power factor of the plant.

Power factor correction for furnace circuits is obtained:

1. By synchronous condensers.
2. By shunt connected static capacitors.

The synchronous condenser has the advantage that it offers improvement in line regulation and some decrease in voltage flicker in addition to its power factor corrective ability. The larger the unit the more economical it will be as a solution for the power factor problem. As a result it has been used only in the case of large furnace installations. Its first cost and maintenance are principal drawbacks to its use.

The static shunt connected capacitor has a low maintenance and lower first cost to recommend it. It was at one time considered necessary to connect capacitors by means of a stepdown transformer where service voltages exceeded 13,000 volts. However our ideas have been modified in that respect, and it is quite possible to dispense with the transformer by connecting standard shunt capacitors of lower voltage rating in groups in which the units are in series. When this is done, the units are protected by special schemes to detect failure of individual capacitors by a continuous and sensitive checking of unbalanced conditions.

The location of shunt corrective capacitors has been a subject of some discussion. Analysis shows that the proper location to get full advantage of the corrective effect of the capacitors is on the high tension side. The slight advantage obtained by putting them on the low tension side to raise the voltage and kw input to the furnace electrodes is more than out-weighed by the low refining voltage which materially reduces the corrective kva obtained, and also by necessity for connecting the capacitors through a step-up transformer to permit the use of 460 volt units.

The decision to use synchronous condenser or static capacitors for power factor correction will be determined in each case by the circumstances. If the installation is small the capacitor will be preferred. If the installation is large the questions of line regulation and voltage flicker may influence the decision. Both have been applied satisfactorily.

DEMAND CONTROL

Consideration of kw and kva demand goes with power factor correction. Many recent installations have been equipped with demand metering and associated equipment to keep the load within certain specified maximum demand limits. Some of the schemes used are

1. The contact of the demand meter gives an alarm to the operator so that he can reduce the load on the furnace.
2. The contact of the demand meter is arranged to trip the circuit breaker on one or more of the furnaces.
3. The contact of the meter is used to recalibrate the furnace regulator so that the load will be automatically reduced without the need of opening the breaker.

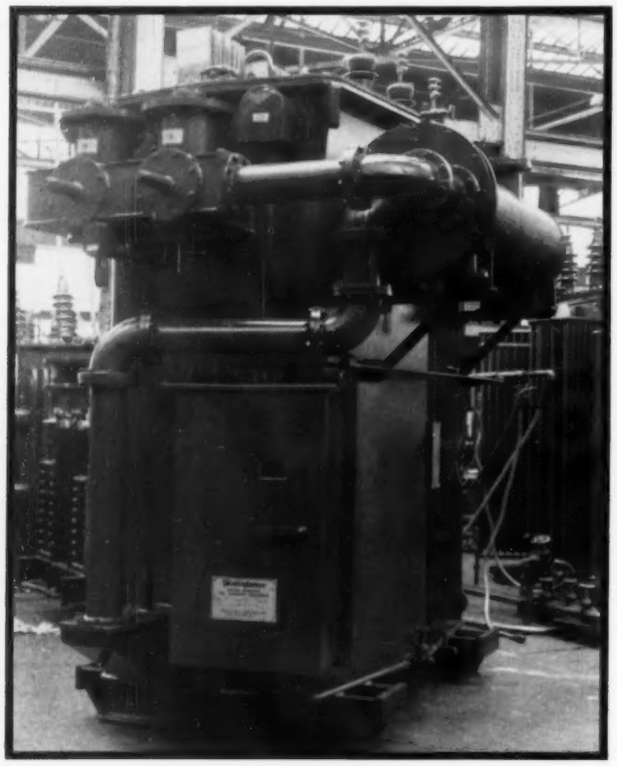
The last two schemes are applied in such a way that only the furnaces which are melting down are affected. Visible and audible signals are given to the operator so that he knows when the demand meter is in control.

The recalibration scheme is preferred in most cases as it does not require the manual reclosing of the breaker each time the demand meter resets.

SURGE VOLTAGE PROTECTION

The industry has been conscious of overvoltages incident to arc furnace operation for several years, and a great deal of test work has been done. While insulation failures due to these transients have been infrequent, there has been sufficient trouble to recommend the use of surge protective capacitors, or else provide a good margin of impulse strength in the insulation of the high voltage equipment.

Figure 6 shows the diagram of connections for the surge protective capacitors on a furnace transformer circuit.



TRANSFORMERS

Progress in furnace transformer design has been principally in methods of manufacture, and details of construction. A few of these improvements are worthy of mention.

In some of the larger units the tank for the tap changer itself is separate from the main tank, and there is also a separate housing for the tap changer motor and mechanism. This permits inspection of the tap changer contacts without draining all the oil from the main tank, and if any trouble should develop in the tap changer it will limit the contamination of the oil to the much smaller volume in the tap changer tank. This feature is shown in Figure 7 which is an external view of a 15,000 kva 25 cycle furnace transformer.

Improvements have also been made in tap changer control and construction for greater reliability so that as far as possible protection for even the most remote contingencies is provided.

An additional low oil level contact is now supplied on the gauge so that warning of any fall in normal level due to a leak can be given before damage is done to the

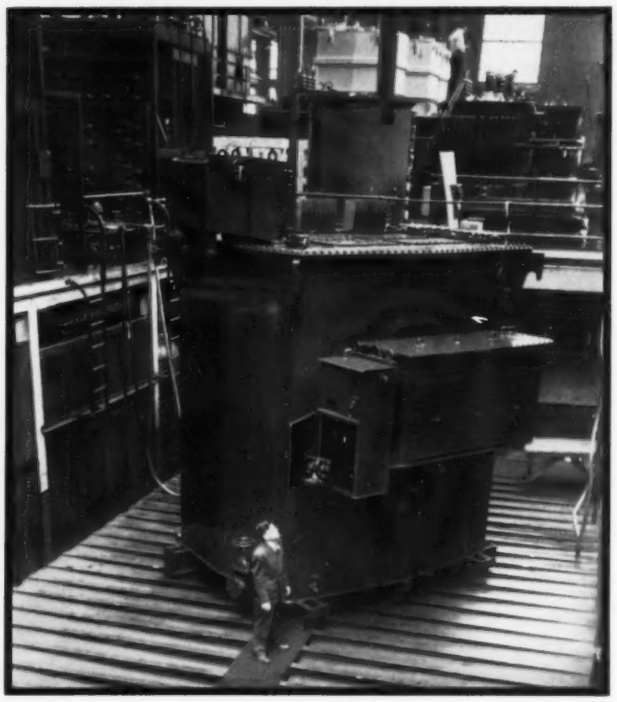


Figure 7 — External view of 15,000 kva, 25 cycle furnace transformer with separate tank for tap changer and separate housing for tap changer mechanism.

Figure 8 — As a wartime conservation measure, steel tubed heat exchangers have in some cases been used, mounted outside of the transformer tank.

transformer. Improved low voltage lead supports and centering arrangement permits adjustment of the low voltage bars to center them accurately in the transformer tank before the final brazing of the coils to the leads.

In the field of application, however, there have been in some cases important departures from long established practices. These are (1) the use of oil insulated, forced oil cooled designs with external heat exchangers, instead of the self contained water cooled design and (2) the systematic and deliberate overloading of furnace transformers.

Both of these are the result of war time economies requiring the conservation of critical materials and the use of existing equipment beyond normal rating, but under prescribed conditions, and within sufficient limits that the life of the equipment should not be greatly affected.

In the first case the heat exchanger is supplied with steel tubes to save copper. Under this condition it is necessary to mount it external to the transformer tank, so that eventual failure of tubes will not endanger the transformer. Figure 8 shows a 10,000 kva furnace transformer of this type with the heat exchanger pumps, and piping all mounted integral with the tank. This design is more compact than the alternative arrangement with heat exchanger separately mounted and connected to the

tank by piping. By special design some saving in size of the transformer itself can be made over the water cooled arrangement, but this is offset by the space needed for heat exchanger and piping.

We believe that this change should hardly be classified as a progressive step since it is only temporary. Furnace manufacturers and users prefer the simplicity and compactness of the standard water cooled design even though the present disadvantage of the force cooled design can be avoided by using copper coils in the heat exchanger.

As far as overloading is concerned, we all know that the furnace users have been doing that long before the war. Now, however, they have our recognition as evidenced by the "Interim Report on Guides for Overloading Transformers and Voltage Regulators" to which those who are interested are referred.

CIRCUIT BREAKERS

Very few applications impose more severe operating conditions on circuit breakers than the control of the power supply to arc furnaces. The breaker is called upon to interrupt fifty to sixty times a day and more frequently in some cases. While it is true that most of these interruptions are opening only magnetizing current, the deterioration of oil in an oil breaker takes place rather rapidly and the mechanical wear and tear, particularly on large breakers, is very severe. In addition to this, the expense of filtering and replacing oil is considerable. Furnaces were formerly relined once every three weeks thus giving an opportunity to properly maintain the breaker. However improvements in refractories and the urge for increased production have resulted in much longer intervals between relining. A great improvement in this circuit breaker maintenance situation resulted when the air circuit breaker was introduced for furnace service about five years ago. Furnace users and furnace manufacturers have both agreed that this type of breaker is the most satisfactory breaker for this service, and installations in recent years have used it whenever possible.

The present air circuit breaker, such as the unit shown in Figure 9, has special provision for the low current interrupting duty which is so frequent in this application. It is generally used in drawout type metal-clad construction. The removable arrangement facilitates maintenance, as the unit can be readily withdrawn from the housing.

It is rather obvious that arc furnace installations involve two conflicting requirements for circuit breakers. One is the normal interrupting capacity duty required of a circuit breaker in case of a short circuit either in the transformer or on the primary side of the transformer. The second is the need for frequent switching of the furnace load or opening in case of prolonged short circuit in the furnace.

In order for a circuit breaker to properly function for condition No. 1 — that is, normal interrupting capacity, it is necessary that the closing mechanism of the breaker be operated with sufficient force so as to enable it to close against heavy short circuit currents in a rapid and positive manner. This sort of operation causes unnecessary slamming of the breaker, with particularly heavy wear and tear, and results in heavy maintenance, when it is used repeatedly on light currents such as required for ordinary furnace switching duty. On the other hand, the second condition, namely, ordinary switching operations at light currents, can be handled with considerably less effort by the closing mechanism, and consequently with much lower maintenance.

Therefore, the present air circuit breaker for furnace service with interrupting capacity limited to furnace load currents or short circuits in the furnace, so that closing effort on the mechanism can be reduced, backed up by a breaker of suitable interrupting capacity, is the most desirable arrangement that can be supplied at the present time.

Figure 9 — This air circuit breaker, in drawout type metal-clad construction, has special provisions for frequent low current interrupting duty. →

Figure 10 — Rotating elements used in one of the new rotating arc furnace regulators. ↓

CONTROL

Early arc furnace regulators were of the current operated contact making ammeter type and were never satisfactory. A major improvement was made many years ago when the balanced beam regulator actuated by current in the electrode and voltage across the arc

was introduced. From that time nearly all regulators for arc furnaces were of that type. It is still being used, and continues to give excellent service.

Recently considerable interest has been aroused by the introduction of rotating arc furnace regulators, an example of which is shown in Figure 10. Figure 11 is a simplified schematic diagram of this unit as applied by our company. In all regulators of this type, the principle of balancing current on the electrode against voltage across the arc, which was established by the balanced beam regulator, has been combined with variable voltage control of the electrode motors.

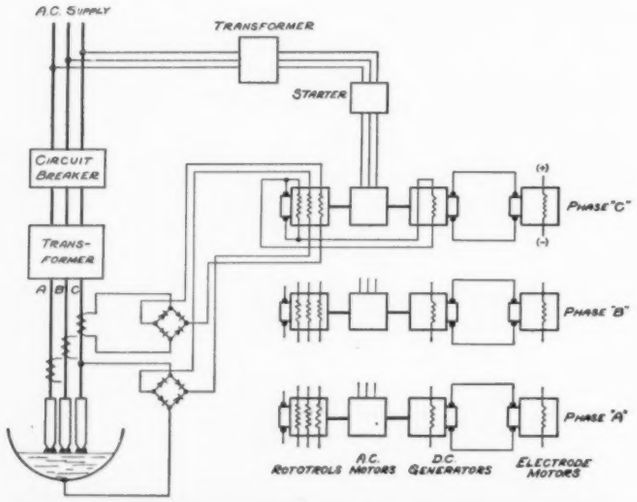
The advantages of this type of regulator are (1) variable voltage control of the motors results in motor torque directly proportional to the average unbalance between current in the electrode and voltage across the arc, and gives a diminishing torque as the balance point is approached; (2) few interruptions of the arc occur during meltdown; and (3) when maximum unbalance occurs as in short circuits, the maximum permissible voltage can be applied to the armature of the electrode motor resulting in a high speed of withdrawal of the electrode.

These advantages are particularly attractive to the furnace users, and several of these regulators are now in service.

CONCLUSION

The excellent record in production of electric furnace steel is proof that development and progress in the furnace design, and in methods of operations, have kept pace with progress in the design of the electrical equipment and the power supply. This record can be bettered if furnace operators will pay closer attention to some of the purely electrical details of operation, such as using secondary voltages and currents which will give the kw they need at the highest power factor. In addition, the importance of maintenance cannot be over-emphasized. It pays dividends in avoiding lost time due to the unforseen accident, which in most cases is forestalled by good maintenance. Better and more dependable apparatus from the manufacturers will help; but apparatus is not the whole story. The operation of electric furnaces to get both high quality and production is an extremely skillful art, and no matter how good the equipment may be, skill in operation will always be the most important factor in achieving this result.

Figure 11 — Simplified schematic diagram of a rotating arc furnace regulator.



DISCUSSION

PRESENTED BY

B. M. JONES, Planning Engineer, Duquesne Light Company, Pittsburgh, Pennsylvania

SAMUEL ARNOLD, 3rd, Consulting Engineer, American Bridge Company, Pittsburgh, Pennsylvania

W. E. LEWIS, Metallurgical Engineer, Pittsburgh Lectromelt Furnace Corporation, Pittsburgh, Pennsylvania

G. E. SHAAD, Steel Mill Section, Industrial Engineering Division, General Electric Company, Schenectady, New York

B. M. JONES: I was particularly glad to listen to Mr. Levy's paper, because in addition to the fine technical story and associated summary, he "carried the ball" for the utilities by pointing out what must be guarded against and what data should be provided by the manufacturers and users.

The steadier the load, the more desirable it is, and the better the rate for power because a lesser amount of facilities is required to carry such loads. Of course, if the output of the furnace can be increased by rampant operation and the furnace banging away with no attempt to control anything, the price of the product from the furnace will have to support the larger electric supply system.

Near the beginning of Mr. Levy's paper concerning the power supply, he said that when the conditions surrounding the furnace installation and operation are known, the power companies can furnish adequate power. In some cases, the difficulty with the power supply lines is the inability to obtain the complete characteristics of the furnace, and its performance. As more and more furnaces are installed and operated, knowledge of these data will become more widespread and hence the matter of obtaining the data will be less of a problem. We hope that day comes soon.

Insofar as power companies in general are concerned, they can build the necessary supply line or lines to carry those furnace loads if they just know what the performance is going to be. There is one thing, however, which is important in the older installations, and Mr. Levy pointed this out in the first part of his paper, viz.

rebuilding and enlarging existing furnaces. This is sometimes done without the knowledge of the power company and it finds out about it later — in the hard way! It would help all concerned to have data on these revamping and enlarging programs passed on to the power company ahead of time. Of course we can fix it up later but that is after the unsatisfactory performance has been encountered. However, this is hindsight and is not so good in such cases.

The explanation of remedial measures for violently fluctuating loads, as outlined by Mr. Levy, was very interesting and should be studied, I believe, by all who are considering this part of the furnace supply problem, particularly by the power company engineers.

The motor generator set is, of course, the best, but in many cases this is probably costly. The set would permit only kilowatts to flow through the shaft, viz. only true power, and the supply system would experience no effect of the poor power factor or fluctuating kva of the furnace load. I expect that a rather large flywheel, in fact a very large flywheel, would be required to take the peaks of the furnaces because of their extremely short duration. Such peaks are of much shorter duration than those encountered in a rolling mill, being of cycles duration rather than of seconds duration. Such a large flywheel would, of course, add to the cost.

Synchronous condensers for reducing lamp flicker and improving voltage regulation have been used at several places in recent years. One such large installation is on the Public Service of Northern Illinois system at Sterling, Illinois, which is connected to a long 132 kv line. A small installation has been made in Canada a year or so ago on a 4000 volt system. Both of these installations have been described before the American Institute of Electrical Engineers, and data thereon can be obtained from the Institute. In our company we have considered synchronous condensers and shunt capacitors for solving such problems, but have not had occasion to make any installations to date. Technically, we think that this will solve the problem, but we must also look at the economical side.

Series capacitors are a solution of a limited nature, and I understand that one installation has been made for a relatively small furnace in South America, which was supplied from a long line. As we all know, each series capacitor has a rather narrow range of application; that is, when built it is tuned for a definite band and cannot "do its stuff" outside that band. Hence, when properly applied on a particular system and line for a furnace, that series capacitor application would no doubt solve that problem. However, where there is much change, such as rearranging the supply system, reinforcing the supply line, or rebuilding and enlarging the furnace, a careful review will have to be made of all such changes, to determine if that series capacitor will solve the new problem. Generally speaking, such capacitors are "custom applied."

The last item under Mr. Levy's comments on remedial measures, "segregation of furnace load," is, of course, the ideal technically — but it is probably costly. Some power systems may be so laid out that this can be done, and I understand that the Detroit Edison Company has parts of its system and busses segregated for fluctuating loads, including electric arc furnaces. Such busses in the supply stations are known as "flicker busses." I further understand that they have their loads of this nature in a rather limited area and can economically afford to do this. We just could not do this on our system because our industrial customers using electric furnaces are scattered up and down the three rivers in our territory, and the supply lines, substations and busses for such furnace load also supply other load, including residential lighting and service to shops, stores, schools, etc.

I was particularly interested in that part of Mr. Levy's paper having to do with power factor and adjusting of the voltage and currents in the furnace. We have proven to our own satisfaction that uninterrupted currents during meltdown periods, even at somewhat lower values than the maximum obtainable, will consume more kilowatt hours and hence naturally will pour more heat into the furnace, thus resulting in faster meltdown. We have made tests with kilowatt-hour meters that prove this and I have talked with engineers in other furnace plants, who have corroborated this statement. However, I feel that some of the operators do not attach sufficient significance to this situation.

Apparatus for power factor correction when properly applied can, with suitable rates, be justified. With the lowering in cost in recent years of the static capacitor, there may be more of a field for these devices, but suitable disconnecting devices will have to be provided with them.

We all know that the control has been the secret of the success of the modern electric arc furnaces, and we are very glad to hear of the new control devices for which the manufacturers have great hopes. We are all interested and are hoping that these new controls show improved performance over the present good old regulators that have been used for a number of years.

The control of the demands from furnaces is very practical and a proven method, and has been used on a number of furnaces quite satisfactorily. This, of course, is warranted only where there is some economical justification, and generally with a very poor load factor and with the loads varying widely it appears to be justified.

We electrical engineers feel that more attention given to the electrical side of the furnace operation will pay dividends, which is also pointed out in Mr. Levy's conclusions. We believe that an electric furnace installation, properly engineered overall, and with the equipment utilized to the fullest extent, will justify the costs and will be a very vigorous competitor in its field.

SAMUEL ARNOLD: Mr. Levy has very nicely brought out some of the salient points with reference to arc furnace equipment and operation. In particular I wish to emphasize the necessity of utilizing energy at the proper power factor. The limit of course of power input to a furnace circuit is at the point of 70.7 per cent power factor but the small gain in power input, as mentioned by Mr. Levy, between 80 per cent power factor and 70.7 per cent power factor, is costly. This of course is due to the difference between the input to the furnace charge as compared to the input to the complete furnace circuit. Mr. Levy mentioned that a simple inspection of the meters would show the operator the point of maximum power input. This is not entirely true for some indicating watt meters are placed on the primary circuit and some of them on the secondary

circuit, and as a result the maximum kilowatt reading in one case would include the losses of the transformer and in the other case these transformer losses would be eliminated. On most of the later furnaces the kilowatt meter is connected to the current transformers on the secondary side of the power transformer and thus the kilowatt meter gives readings of power input to the furnace circuit including secondary leads and electrodes but excluding the losses to the transformer. former.

Assuming a furnace with the kilowatt meter connected to the secondary side of the power transformer, the maximum kilowatt reading at a given secondary voltage would indicate a power factor of the furnace circuit excluding transformer, to be approximately 70.7 per cent, and as previously mentioned an operational power factor somewhat higher than this is desirable. As a rule of thumb, therefore, I suggest that the furnace operator determine the maximum kilowatt input at any given voltage by observing the point at which the indicating watt meter shows no further kilowatt increase to the furnace circuit. The current value should then be reduced say approximately 5 per cent from the values obtained at this reading. With these new values of current, the power factor would be reasonably improved and the furnace operated at a somewhat more efficient power factor level.

It has also been suggested that power factor meters be utilized. This was done years ago but due to the inaccuracy of an indicating power factor meter when the load is unbalanced, the readings obtained on these instruments have been practically valueless. Some thought is now being given to developing a means of indicating an average power factor which will be a further benefit to the furnace operators.

W. E. Lewis: We have found Mr. Levy's paper very interesting. It reviews the progress of methods and equipment for supplying power to arc melting steel furnaces in a very thorough manner.

Sufficient reactance has, in general, been specified in transformers for furnaces to meet most power companies' conditions. Only exceptional cases have required remedial measures such as synchronous condensers.

We believe that, especially in the past, the matter of the most desirable kilowatt input to furnaces in association with high power factor has not received the attention it merits. When a furnace is installed, all regulator, voltage and reactance adjustments and selections are made to best accommodate the practice and the power company's conditions. However, often times additional production is desired which results in the user overloading to reach an increased hourly output rate. A concrete example of what can happen under this condition came up in connection with a recent investigation of a request that additional cooling be provided for the transformer due to the necessity of increasing production.

In this particular instance it was found that the total impedance on the 40 C rise basis was 32.62 per cent on the melt down and the impedance with the current at which the user was operating 63.6 per cent. These readings were obtained on the primary side. The reactance was decreased 10 per cent which was found for the same kva demand to increase the power factor from 70 to 85 per cent and the kw input from 1050 to 1350. The top oil temperature decreased from 70 C to 65 C. The overloading, however, even on the distinctly improved basis of operating, required additional cooling to be considered, as the top oil temperature should be considerably below 65 C.

The specification of a furnace transformer with a four position tap changer providing a selection of reactance independent of the voltage selected was initiated in September of 1930. The tap changers were mounted inside the transformer tank. To date these tap changers, which are safety interlocked, have required no attention.

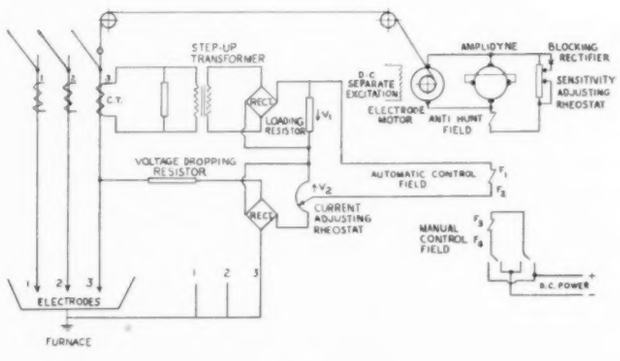
Where bad water conditions exist or it is desired to obtain additional capacity from a transformer, an outside cooler or heat exchanger has been added with very good results in quite a number of instances. This outside cooler can conveniently be made up of standard pipe with close return bends. The pipes are arranged horizontally, one above the other, and may consist of one or more sections over which a quantity of cooling water is allowed to flow. The oil is circulated through the cooler by means of a centrifugal pump. This arrangement cools by evaporation as well as by conduction.

G. E. Shaad: Mr. Levy has presented an excellent review of the equipment and problems involved in the electrical equipment for arc-furnaces. His paper should be of assistance to many engineers as they review their systems or plan for new installations.

The severe conditions of operation imposed upon the furnace transformer require that the transformer be conservatively designed, both electrically and mechanically. We have standardized on the use of a vertical core and circular concentric winding to give mechanical strength, uniform current distribution, and protection against short circuit stresses, at the same time obtaining a uniform cooling of core and coils. The continuity of service demanded from the furnace transformer demands that long operating life without maintenance take precedence over ease of maintenance, although both factors are to be considered.

The primary circuit breaker, as a result of the highly

Figure A — Schematic diagram showing a rotating type of automatic electrode regulator for one phase of the arc circuit.



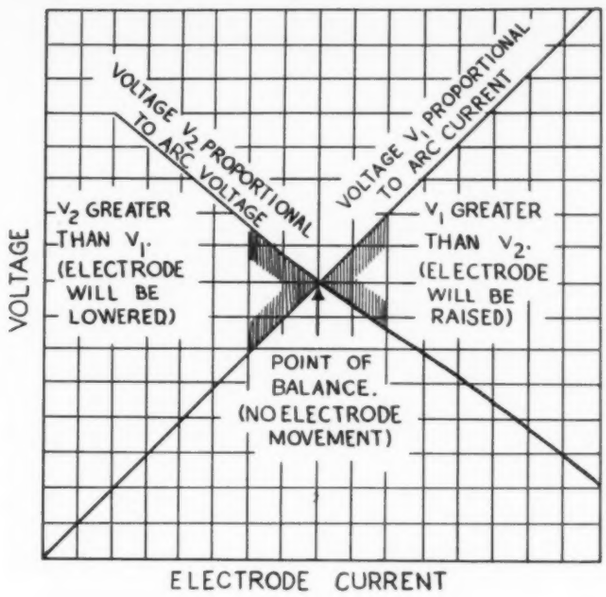

VOLTAGE V2 PROPORTIONAL TO ARC VOLTAGE
VOLTAGE V1 PROPORTIONAL TO ARC CURRENT
V2 GREATER THAN V1. (ELECTRODE WILL BE LOWERED)
V1 GREATER THAN V2. (ELECTRODE WILL BE RAISED)
POINT OF BALANCE. (NO ELECTRODE MOVEMENT)
VOLTAGE
ELECTRODE CURRENT

Figure B — Curves of arc voltage and electrode current as balanced in the generator field of a rotating regulator.

repetitive service, has always been a problem in this work; but the development of air circuit breakers has solved many of the problems. The elimination of the oil with its attendant filtering problem and the design of the breaker for repetitive service have tremendously reduced the maintenance problem. The principle of inserting resistance by stretching the arc allows the arc to be extinguished at an early current zero without forcing abrupt changes in current. By the use of this principle, surge voltages resulting from breaker operations are greatly reduced.

The combination of the air breaker with metal-clad construction provides the ease of maintenance so desirable for furnace operation. A thorough inspection of these breakers can be made in a short time, even between heats without delaying the furnace operation. It is of interest to note that the actual installed cost of metal-clad equipment with its attendant safety features and ease of maintenance is little if any more than the installed cost of old style frame mounted breakers.

As Mr. Levy has pointed out, one should not expect a repetitively operated breaker to protect against primary fault conditions, consequently, the furnace breaker should not be relayed from the high tension side, but provision should be made for primary faults to be interrupted by a back-up breaker. One precaution, however, must be taken in this application. The back-up fault protecting breaker cannot be relied upon to open a primary fault in less than 8 cycles, and during this period full fault current is passing through the furnace operating breaker. The furnace operating breaker must, therefore, have sufficient mechanical strength to withstand the magnetic forces involved during this period.

There has been an increasing realization in the arc-furnace industry of the importance of the automatic control system, and its influence on the time required for melt down, the power consumption, the refractory life, the electrode consumption, the carbon pick-up and the electrode motor and hoist maintenance. The new rotating type electrode regulators have shown outstanding results in service, and as more and more of these units are installed, the advantages will become universally recognized.

In order to obtain the maximum benefits, the control must have a simple straightforward circuit and require little or no maintenance. At the same time, it must provide sensitive accurate control with a nearly instantaneous response to rapidly changing conditions.

The rotating control as designed by the writer's company is shown schematically in Figure A, each electrode motor being driven by its individual special generator, speed and rotation of the electrode motor being dependent upon the voltage applied. A balanced system supplies the generator control field, any unbalance immediately applying field and the resulting power output driving the electrode motors to raise or lower the electrodes as required. As shown in Figure B, the voltage applied to the electrode motor is proportional to the amount of unbalance, giving high electrode speeds where needed, and moving the electrode smoothly into position without overshooting or jogging.

The improved performance of this control justifies its installation in many ways. For example, an increase of 5 per cent in production resulting from decreased meltdown time justifies the expenditure of 5 per cent of the installed cost of a new furnace. A reduction of 1 per cent in power consumption seems like a small amount, but on 25,000 tons a year of steel production, a 1 per cent saving in power is $1000.00 in power cost. A 1 per cent saving in electrode consumption amounts to a considerable yearly saving and the same is true of the many other items. The savings involved will vary a great deal, depending upon the present equipment, and the present method of operation, but it will be well worthwhile to investigate these possibilities.

C. C. Levy: With reference to Mr. Jones' discussion I was very much interested in the supporting arguments given in regard to power supply for arc furnace circuits.

With reference to his comments on the flywheel motor generator set scheme, I cannot agree with his thought that a very large flywheel would be required to take the peaks of furnaces because of their extremely short duration. In fact the case is entirely opposite since the energy delivered by a flywheel to the system is measured in kw-sec; therefore the shorter the duration of the peak of power required by the furnace, the smaller a given flywheel would have to be to deliver that value of kilowatts.

The advantage obtained by uninterrupted current input to the furnace at the correct value of power factor will, in my opinion, be the final answer to this question of the optimum operating condition for electric furnaces. I am certain that many furnace operators are conscious of this and will follow their electrical operating conditions much more closely than they have in the past.

I agree with Mr. Arnold's comments in regard to the proper location of the watt meter which should be on

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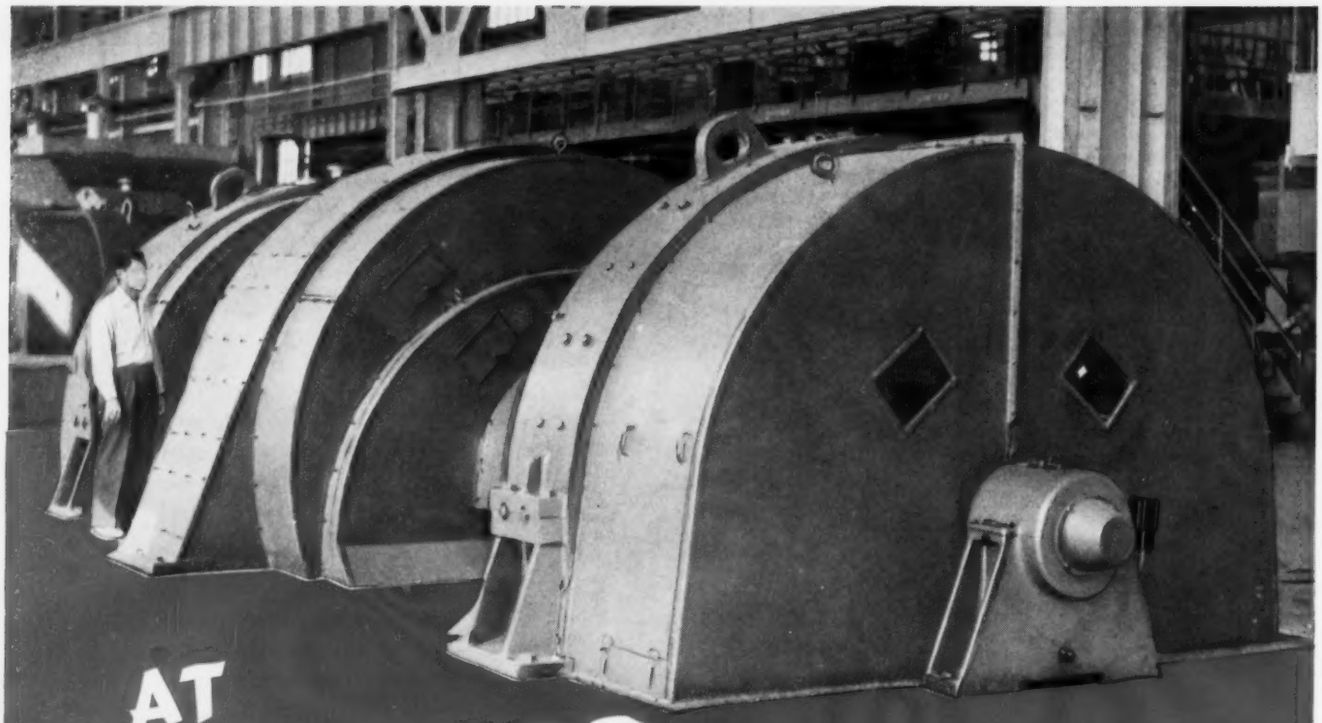

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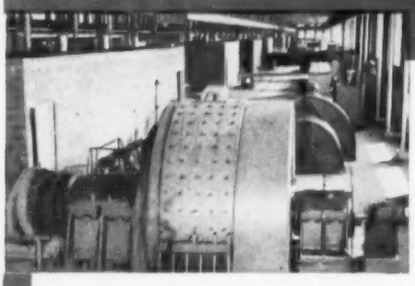

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2-stand Tandem Cold Mill, No. 1	(2)-2250	4200
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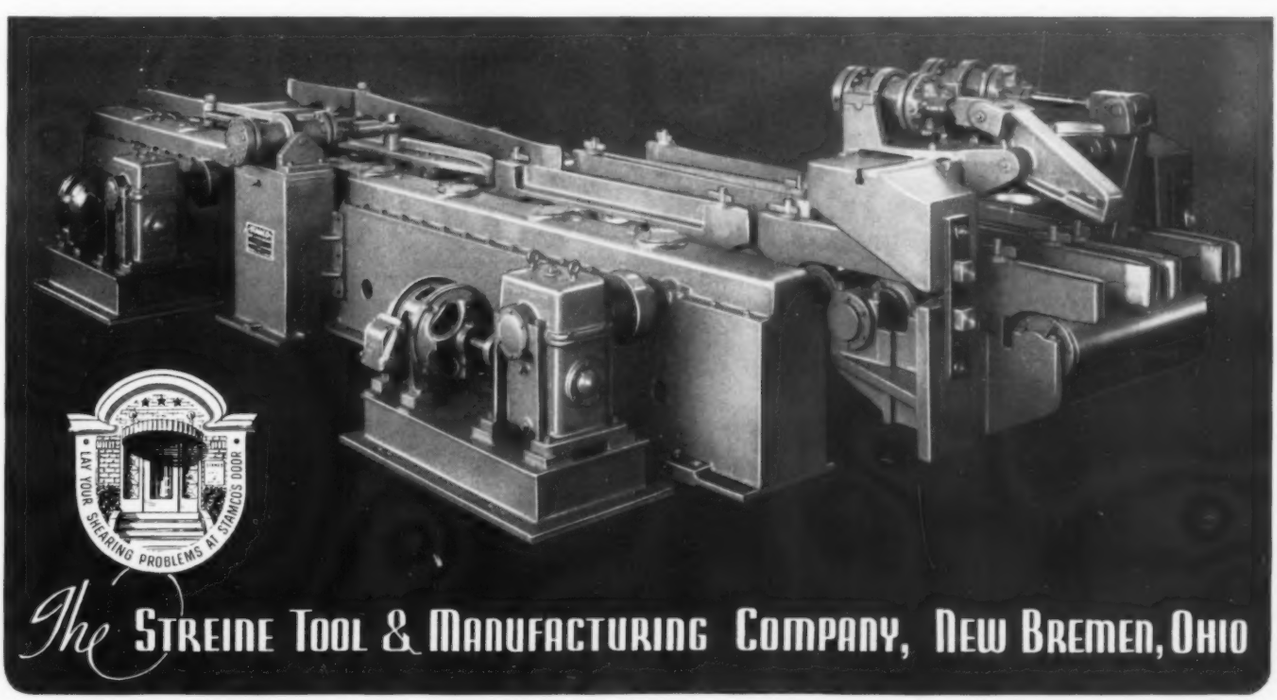

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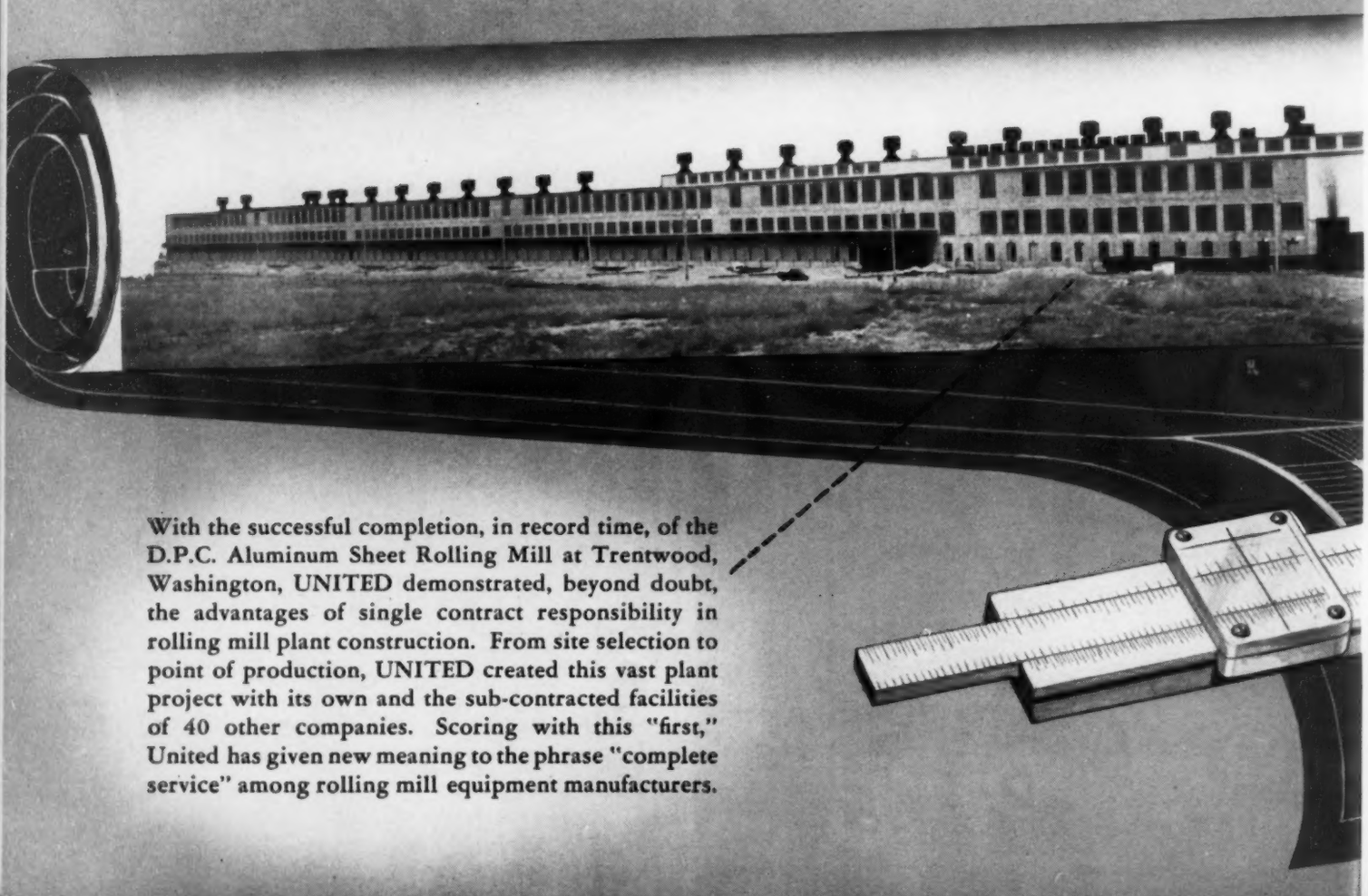

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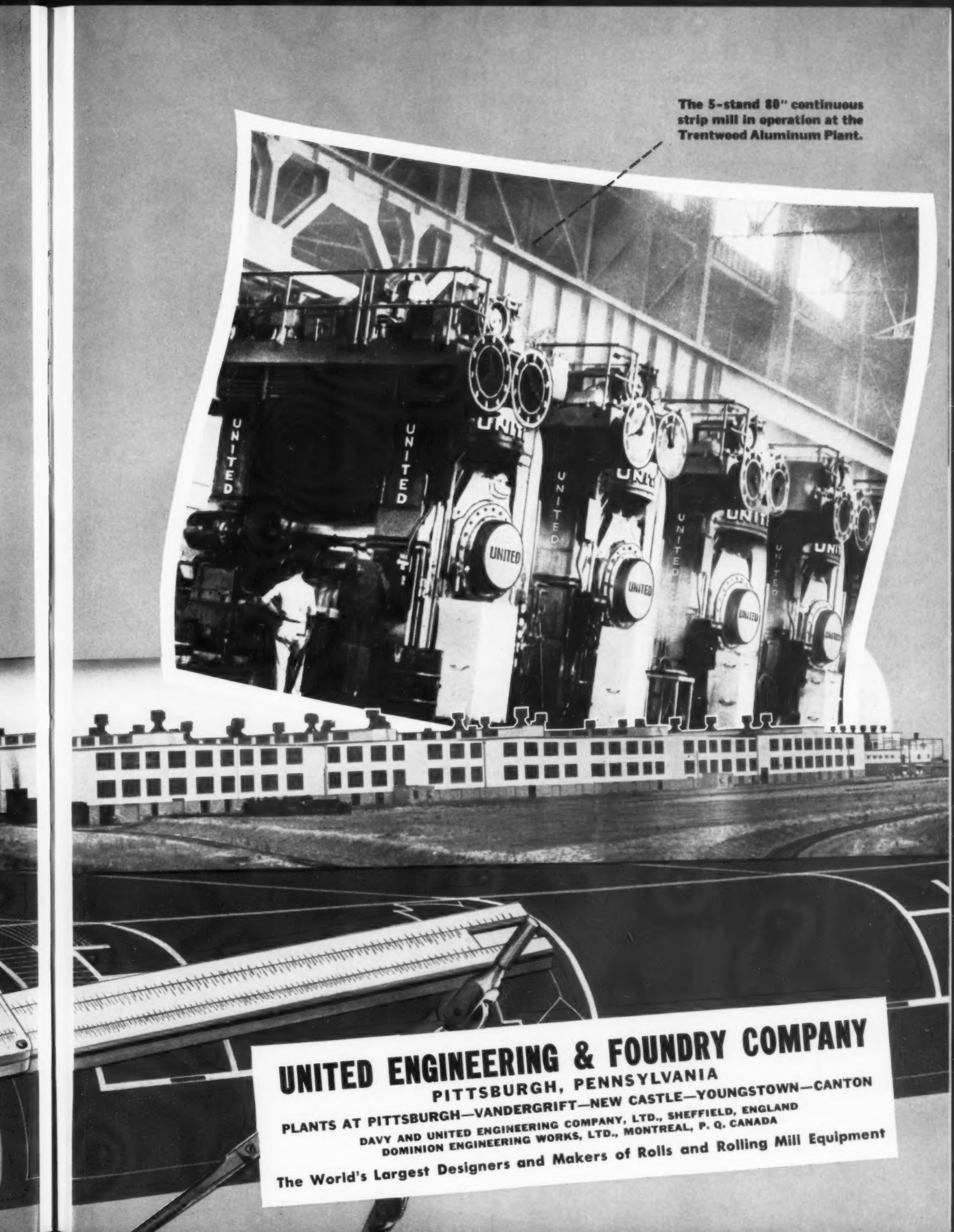

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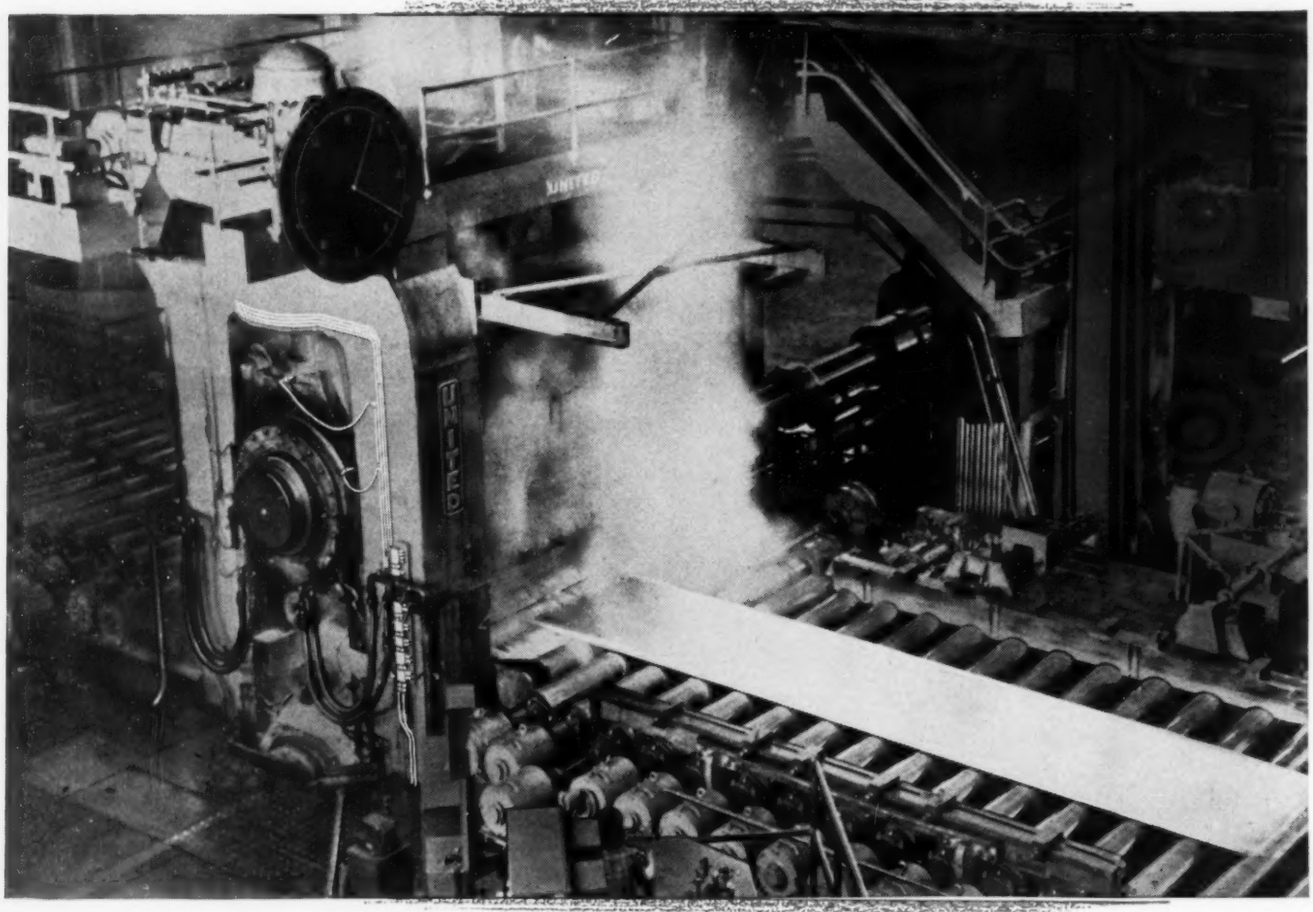

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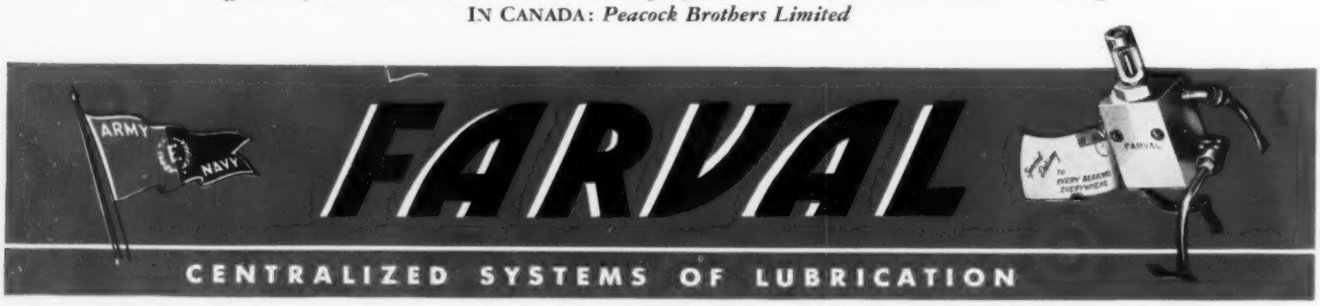


ALUMINUM at TRENTWOOD

. . . first aluminum sheet mill west of the Mississippi River and one of the largest in the country, this plant was built in record time for DPC . . . . with some variations for the metallurgy of the product, the practice is quite similar to the continuous production of steel sheets . . . .

by T. J. Ess

▲ ONE of the largest plants devoted entirely to the production of aluminum sheets, the recently completed Trentwood plant, owned by Defense Plant Corporation and operated by the Aluminum Company of America, represents the modern developments in design and layout of melting, heating, rolling and finishing equipment. In general, the plant parallels the layout of the continuous wide strip mills installed in the steel plants. The process naturally varies somewhat from that used in the production of steel strip, in accordance with the characteristics and metallurgical requirements of aluminum. However, much of the equipment is similar, and the steel plant engineer will find himself on familiar ground in the following description of a modern aluminum rolling plant.

The Trentwood plant is located on a site of 515 acres in the Spokane River valley, approximately 12 miles east of Spokane, Washington, and served by two railroads. Approximately 56 acres are covered by the main mill buildings, which are for the greater part of flat roof construction, with ventilators. The melting, casting, preheating and scalping buildings roughly form the top of a T, with the hot mill building forming the upright. At the bottom of the T, annealing, cold reduction, finishing and shipping buildings extend out to the right, all so laid out and interconnected as to afford free, continuous flow of material throughout the entire process. The layout is also such that additional melting and heating capacity can be added merely by extending the buildings forming the top of the T. In addition to the main mill buildings there are more than 40 other buildings, including offices, laboratories, locker rooms, pump and boiler houses, etc.

Ground was broken April 1st, 1942, and the first carload of sheets made entirely in the Trentwood plant was shipped April 26th, 1943, a remarkable record of engineering and construction. Construction was entirely completed in August, 1943, when the plant was officially turned over to the Aluminum Company.

The Trentwood plant is not designed to produce aluminum from its basic ore, but only to produce aluminum ingots and sheets from aluminum already reduced in other plants. Pig aluminum is received from aluminum reduction plants by rail or truck, and stored in the melting building. Here are located a number of reverberatory remelting furnaces, fired with coal and fuel oil. These furnaces extend over into the casting building, and are arranged in pairs. The furnaces are charged with aluminum pig, plant and customer scrap, and the desired alloys. Bulky scrap, such as chips, cuttings, sheet scrap, etc. are compressed into bundles in three hydraulic operated balers using a solution of soluble oil in water under pressure. Aluminum derives strength and toughness from alloying with small amounts of copper, magnesium, manganese, etc. An alloy widely used for aircraft purposes (designated 24-S) contains 4.5 per cent copper, 1.5 per cent magnesium, and .65 per cent manganese. Melting proceeds under a furnace temperature of about 1400 F.

As is the case with many of the non-ferrous metals, aluminum ingots require "scalping" before being rolled into sheets. When cold the ingots are taken to the

T. D. Jolly (center), vice-president of Aluminum Company of America, confers on Trentwood plans with J. W. Schreiber, chief construc- engineer (left) and B. C. McFadden, chief mechanical engineer.

scalping department, where three scalping machines are installed. Essentially large milling machines, these units have 44 tungsten carbide tipped tools set in a head forming an end milling cutter, which can shave a sizeable slice from the flat side of an ingot at a feed rate of 180 in. per minute. Ingots are placed and turned in the machine by a hydraulic manipulator, and the entire cutting operation and return is automatic. The cut taken on each side of the ingot is sufficient to remove surface segregation and irregularities, and give a flat, smooth ingot of uniform thickness.

Either regular uniform products or clad products may be produced. In the latter case, a pure aluminum sheet is attached to each side of the scalped ingot. The three layers are each reduced in the same relative degree. Thus, the strength of the alloyed core is combined with the corrosion resistance of the pure aluminum cladding.

Ingots are placed, in a vertical position, into steel baskets which are then loaded by overhead crane into the soaking pits. During the heating time the ingot may be brought up to a temperature of 925-960 F for metallurgical reasons, and then allowed to equalize out at the rolling temperature which is about 800 to 850 F. Temperatures are controlled automatically within close limits.

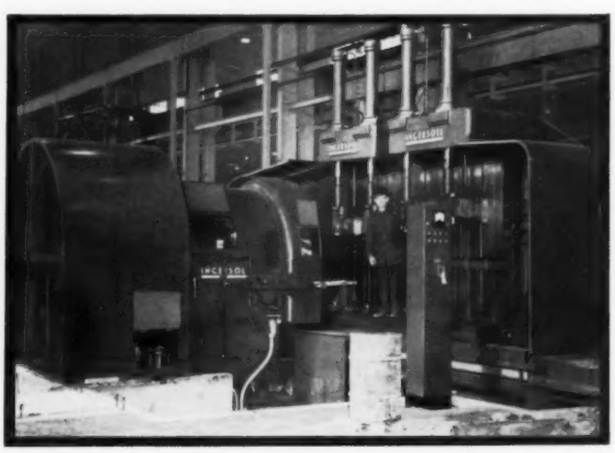
When ready for rolling, the ingots are drawn individually by a stiff leg pit crane, and placed on the hot mill approach table, which runs at right angles to the group of melting buildings. The initial roughing occurs in a 36 in. and 54 in. x 120 in. four-high roughing stand, driven directly by a 5000 hp, 0-30-60 rpm, 750 volt d-c reversing motor. This motor receives power from a flywheel motor generator set consisting of two 2000 kw, 750 volt d-c generators driven by a 4000 hp, 6600 volt, 514 rpm induction motor.

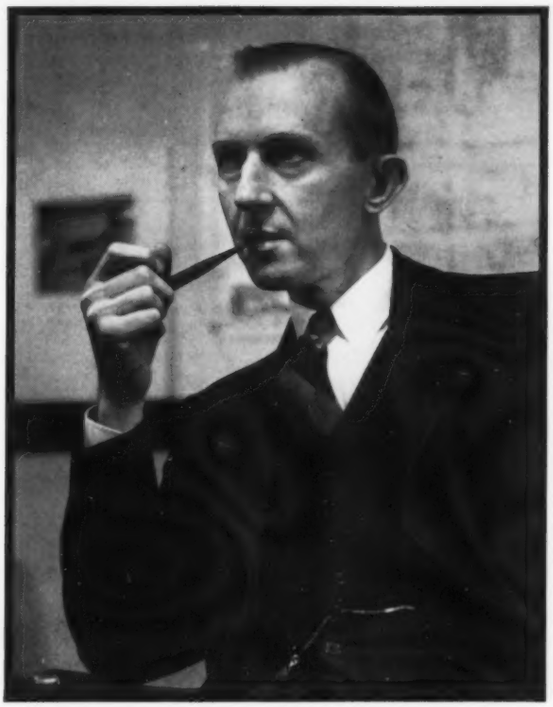
Maximum roll lift of the 120 in. stand is 12 in., which adequately accommodates the usual ingot thickness. Screwdown mechanism is driven by two 75 hp motors, and may be operated under an automatic preset pass scheduling system.

The 120 in. stand is provided with turning facilities which allow the ingot to be turned 90 degrees for broadside rolling, thus producing slabs wider than the original ingot width. Finished widths up to 72 in. are produced.

Following the 120 in. mill stand is a 3 in. down-and-up cut shear, hydraulically balanced and driven by two 250 hp motors under variable voltage control. After the ends of the slab have been cropped, slabs are removed for reheating in 16 electrically heated car-type recirculating furnaces located in a building extending at right angles from the mill building. Two 3-ton cross transfer cranes handle slabs from mill to furnaces and back again. Small electric "mules" push the cars into and out of the furnaces.

Surface irregularities on the aluminum ingot are removed in this motor-driven scalping machine. Ingots are placed and turned in the machine by a hydraulic manipulator.





John L. Young, vice-president of United Engineering and Foundry Company, was manager on the Trentwood project for United, who, with Aluminum Company of America, were principal contractors.

After reheating, slabs are rolled in a 28 in. and 54 in. x 112 in. four-high reversing stand, similar in general design to the 120 in. mill and capable of doing most of the usual work of the 120 in. stand. In fact, initial operations of the plant were begun on this mill, before the 120 in. stand was completed. The 112 in. stand, located 340 ft away from the 120 in. stand, is driven by a 5000 hp, 0-40-80 rpm, 750 volt d-c reversing motor which receives power from a 4000 kw flywheel motor generator set duplicating that provided for the 120 in. mill. Turning facilities duplicating those of the 120 in. stand are provided, so that broadside rolling may be done if desired.

Ahead of the finishing train there is a 1½ in. x 90 in. down-and-up cut, hydraulically balanced shear driven by two 100 hp motors. The blades in this shear are slightly "saw-toothed," so as to give a wavy end to the break-down to facilitate entry into the finishing mill rolls. A rotary side trimmer, with a maximum capacity of 1 in. x 86 in. and automatic width adjustment, trims off cracked edges, thus reducing the tendency to further cracking during the finish rolling. Rotary scrap cutters chop the side trim into 2 ft lengths.

The breakdown then proceeds to the continuous finishing train, located 367 ft 9 in. away from the 112 in. mill stand. This unit consists of five 28 in. and 54 in. x 80 in. four-high stands on 13 ft 6 in. centers. Each of the first four stands are driven by a 4000 hp, 175-350 rpm, 600 volt d-c motor and the last stand is driven by a 2250 hp, 250-550 rpm, 600 volt d-c motor.

The entire finishing train receives power from two motor generator sets, each consisting of two 3000 kw, 600 volt d-c generators driven at 360 rpm by an 8400 hp, 6600 volt synchronous motor.

In the five stands of the finishing train, the strip is reduced to thicknesses usually ranging .09-.125 in., and is delivered at speeds up to a maximum of about 900 fpm. Heavier sections are also rolled, such as ¼ in. plate, etc.

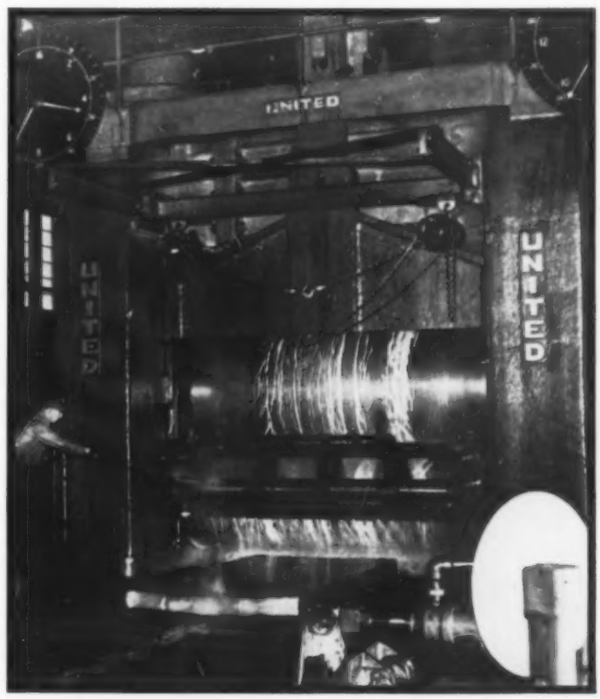
All work rolls in the hot mill stands are of forged steel or alloy iron, while back-up rolls are cast steel. Roller bearings are used on the roll necks of all work and back-up rolls. Mill pinions operate in babbitt bearings, while reduction gear sets are equipped with roller bearings. Automatic systems provide lubrication for all bearings, gear faces, and other points requiring oil or grease.

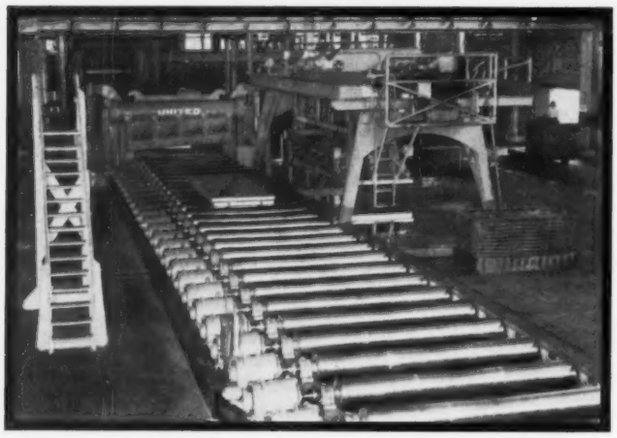
Screwdowns of all hot mill stands are driven by two 75 hp, 230 volt, 515 rpm compound wound d-c mill type motors.

The hot mill motor room, 1380 ft long x 60 ft wide, parallels the hot mill building and houses all of the main drive motors, reduction gear sets and pinion stands, as well as the switch-gear, motor generator sets, exciter sets and control equipment for these units. Transformers, motor generators and their switchgear afford 440 volt a-c and 250 volt d-c power for mill auxiliaries. Large rotating machinery is ventilated by a closed, circulating down-draft system, cool air being forced up into the room and down through the machines, through tubular surface-type air coolers, and back up into the motor room. Make-up air for this ventilating system is filtered.

Following along the mill runout table, the strip passes through a ½ in. shear for squaring up the ends, and a

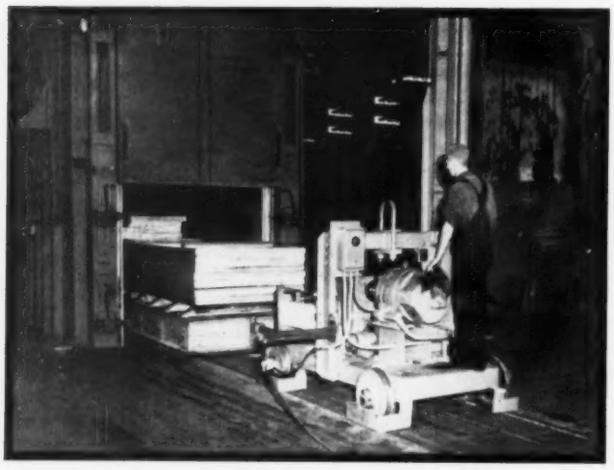
This four-high 36 in. and 54 in. x 120 in. reversing rougher reduces the ingot into slab form. The mill is driven by a 5000 hp motor.





After the initial roughing, slabs are sheared in a 3 in. down-and-upcut shear, then removed from the table by a take-off crane for reheating.

Small electric "mules" push the slab cars into electrically heated car type reheating furnaces.



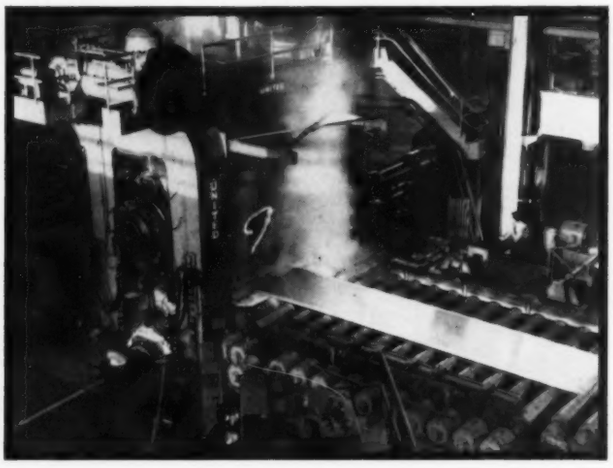
rotary side trimmer (which can also be used as a slitter), and finally goes to an up-coiler with three motor-driven coiling rolls and motor-driven pinch rolls. Coiler speed is synchronized with that of the side trimmer. The coiler is located about 500 ft from the last finishing stand. Cooling sprays are placed along part of the runout table, spraying the strip with a soluble oil solution. The same type of solution is used throughout the hot mill for cooling the rolls and providing a lubricating film between the steel rolls and the aluminum stock.

Over 500 table motors drive the rollers in the hot mill line, ranging from ¾ hp up to 25 hp. All of these units are 250 volt d-c, operating under variable voltage control. Table sections adjacent to the reversing stands are operated in conjunction with the mill, reversing back and forth as in conventional blooming mill practice.

The coils are next loaded on steel racks which are pushed into annealing furnaces by motor operated car pullers. These annealing furnaces are located in a building running at right angles to the hot mill building. The annealing furnaces have electrical heating elements located in each side of the furnace, and fans circulating hot air through the heaters and the charge. Electrical circuits are so connected that stoppage of any fan will open the heating power circuits. An annealing temperature of approximately 700 F is used, and the material is then slowly cooled to room temperature.

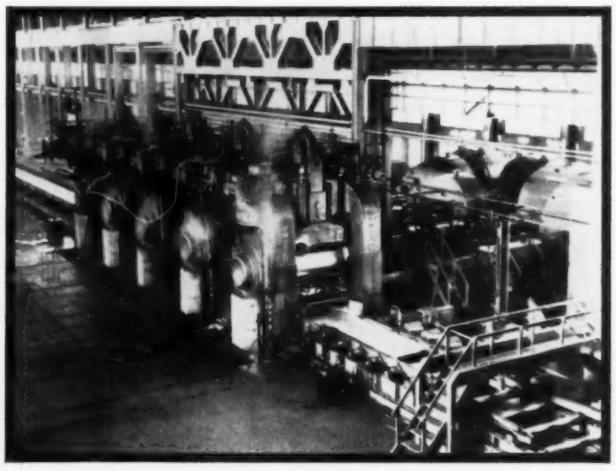
Coils are now ready for cold reduction, which is done in any of three cold mills. The first of these is a two-stand tandem mill consisting of two four-high stands spaced 13 ft, 2 in. apart, each driven by a 600 volt d-c motor through gear reductions of 6.23 and 3.73, respectively. A motor generator set consisting of two 2000 kw and one 200 kw generators, driven by a 5900 hp, 6600 volt, 514 rpm synchronous motor, provides power for the drive and reel motors. Screwdowns on each stand are operated by two 50 hp, 230 volt, 550 rpm compound wound d-c mill motors.

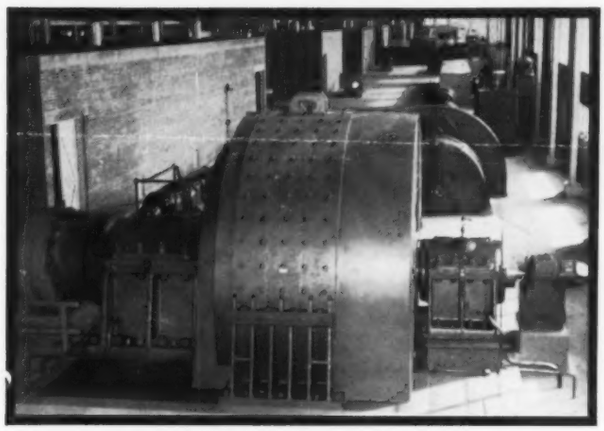
Two single-stand, four-high mills, 20 in. and 49 in. x 71 in., are also provided, each driven by a 2250 hp, 250-550 rpm, 600 volt d-c motor. Each mill receives power from a motor generator set consisting of a 2000 kw and a 200 kw generator driven at 514 rpm. One set is driven by a 2800 hp synchronous motor, while the other has a 5900 hp motor in anticipation of the addi-



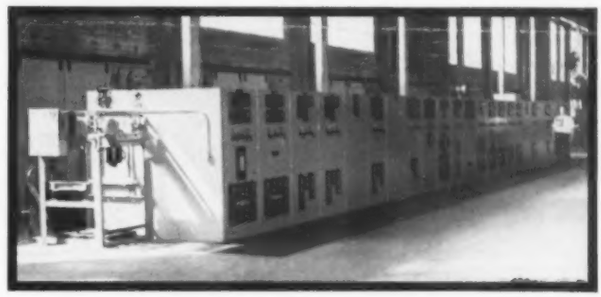
The second step in the rolling process occurs in this 28 in. and 54 in. x 112 in. reversing mill, which is driven by a 5000 hp motor.

After end and side-shearing, the aluminum break-down passes through this tandem finishing train consisting of five 28 in. and 54 in. x 80 in. stands on 13 ft 6 in. centers.





All main drive motors, reduction gear sets and pinion stands, as well as motor generator sets, switchgear and control equipment for the hot mills are located in the motor room.



tion of a second mill stand and generator. Two 50 hp motors drive the screwdown mechanism for each mill, and two 125 hp motors drive each reel.

The cold mills are equipped with forged steel work rolls and cast steel back-up rolls, all operating in roller bearings. Babbitt bearings are used on the pinions, and roller bearings on the reduction gear sets.

Coils are placed in a cradle and fed through a "bridle" into the mill rolls. On the delivery side, the strip is recoiled on a reel or in a coiler, depending upon the thickness.

Further intermediate annealing may be required if a considerable amount of cold reduction is required. Ten furnaces are installed for this purpose.

Three flying shear cut up lines reduce the cold rolled coils into sheet form. In order to increase strength and ductility of the product, the sheets are next given a heat treatment in vertical type furnaces, also heated by electric resistance heating elements. The heat treating operation causes a certain amount of buckling in the sheets, which is removed by flattening in skin pass mills, roller levelers or stretcher levelers.

A train of 12 two-high hand mills, mounted side by side and driven through a gear reduction of 13.44 ratio by a single 1250 hp, 6600 volt, 360 rpm squirrel cage motor, provides skin passing facilities, imparting flatness, luster and physical properties to the sheets. Ten stands use rolls 32 in. x 84 in., and two wider mills have rolls 32 in. x 110 in. Sheets are passed through the mill by hand with a rolling speed of 223 fpm, with thin sheets being pack-rolled. Roller levelers are of two-high, nine roll type, while the stretcher levelers, hydraulically operated, are capable of setting up a pull of 500,000 lb, and in one large unit, 1,500,000 lb.

Final shearing to size is accomplished in a number of combination side and end resquaring shears. Carried into the shear by conveyor belts, the sheet is stopped automatically by an "electric eye," and both sides are sheared simultaneously. The sheet is then carried forward to the end shears, which operate simultaneously under manual control. The finishing departments also contain miscellaneous side trimmers, shears, slitters, etc.

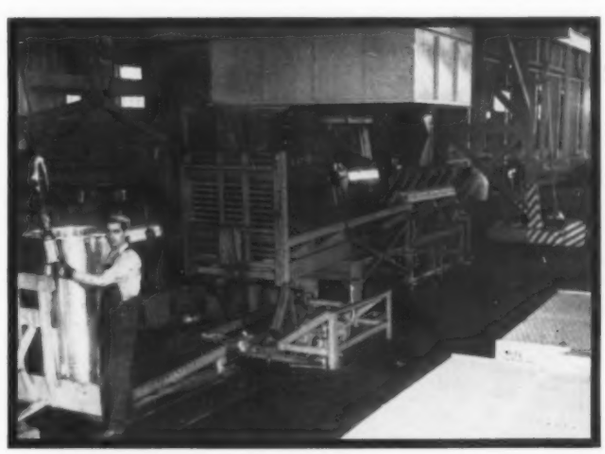
After the final shearing, the finished sheets pass on for inspection, marking and shipping. Inspection is carried out in much the same manner as tinplate inspection. A number of combination oiling and marking machines are installed in the inspection department. Finished sheets are packed in boxes and loaded into box cars or gondolas for shipment to aircraft or fabricating plants.

Power for the plant is supplied from the Bonneville Power Administration, entering through a 115,000/6900 volt substation of 75,000 kva capacity. By adding forced cooling, this capacity can be increased to 100,000 kva. Power is transmitted into the mill over four overhead three-phase lines. The connected motor load on the 6900 volt system totals 44,650 hp, with motors ranging from 700 hp to 8400 hp. The connected 6900/440 volt transformer capacity is 70,000 kva, the larger part of this being used for the electric heating and treating furnaces. There are nine 4000 kva units, eleven 3000 kva units and one 1000 kva unit, of which one 4000 kva unit, three 3000 kva units and the 1000 kva unit are on power distribution and the balance on electric furnaces.

The hot mill employs 24 units of indoor 6900 volt metalclad switchgear, while 19 units are applied to the cold mills. Circuit breakers are of 1200 and 2000 ampere rating, of 500,000 kva interrupting capacity.

Auxiliary power systems are 440 volt three-phase, and 250 volt d-c. There are five 440 volt three-phase indoor metal-clad switchgear substations and three 250 volt switchgear installations, equipped with automatic reclosing feeder breakers. A [illegible] kw motor generator set supplies 250 volt d-c power to each of these three distri-

Located about 500 ft from the last finishing stand, the up-coiler is synchronized with a rotary side trimmer which precedes it on the runout table.



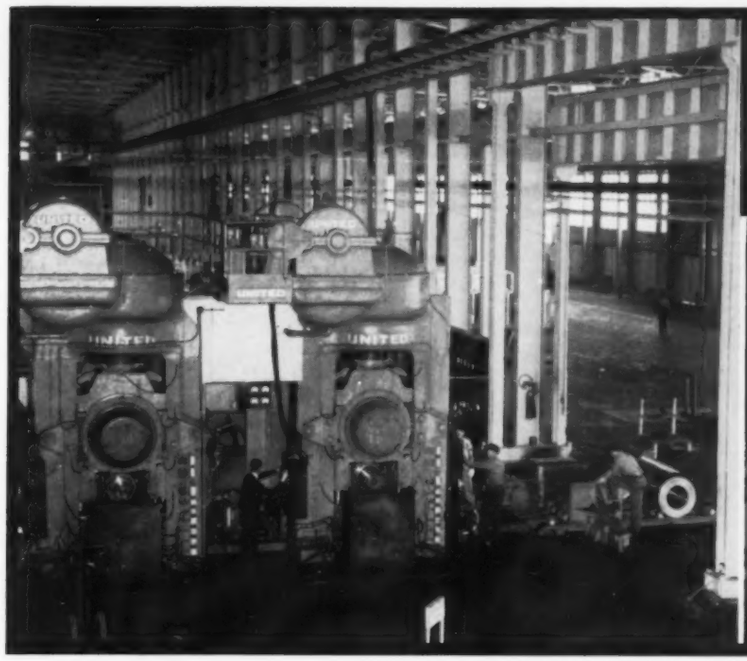
BUILDING AND CRANE DATA

Building	Building size, ft	Cranes	
		Number	Capacity, tons
Melting building	1420 x 80	2	5
Casting building	1420 x 80	4	20
Coke storage building	240 x 160*	.....	.....
Preheating building	1400 x 80	3	20
		1	5
		2	Pit chargers
		2	Stiff leg
Storage and scalping building	680 x 80	1	20
Furnace building	240 x 80	.....	.....
Hot mill building	1380 x 80	1	20/5
		1	80/20
		2	3 ton cross transfers
		1	Monorail
		1	2 ton gantry
Motor room	1380 x 60	1	50/15
		1	20
Mill extension building	640 x 80	2	5
Reheating furnace building	380 x 160†	2	20
Machine shop	400 x 140†	1	50/10
		2	5
Shop building	400 x 60	1	5
Storeroom	240 x 240‡	.....	.....
Roll shop	240 x 80	1	50
Cold strip and annealing buildings	1520 x 200†	3	50
		1	80/10
		1	5
Shearing and vertical anneal buildings	540 x 240†	1	10
Storage building	1200 x 80	1	10
Shearing and storage building	1520 x 80	1	25
Skin pass and shearing buildings	880 x 240†	1	20
		2	10
Inspection and shipping buildings	1600 x 160*	4	10

*Two bays wide. †Three bays wide. ‡Four bays wide.

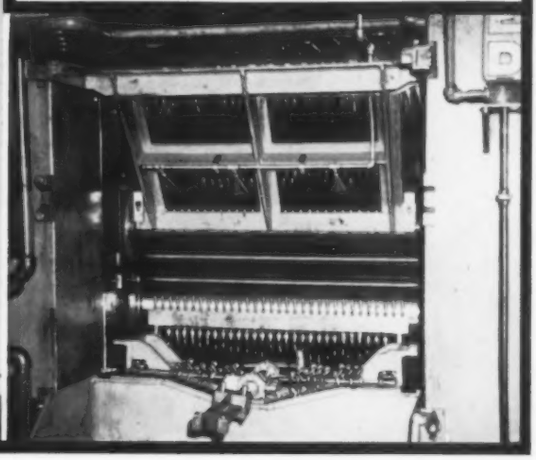
MILL DATA

Stand	Characteristics	Diameter, in.		Roll body length, in.	Motor				Remarks
		Work roll	Backup roll		Hp	Volts	Rpm	Type	
Hot Mill									
Edger	1 stand, vertical	32	....	12	400	750	125–500	d-c	Geared
Reversing rougher	1 stand, 4-high	36	54	120	5000	750	30–60	d-c	Direct
Reversing rougher	1 stand, 4-high	28	54	112	5000	750	40–80	d-c	Direct
No. 1 finisher	1 stand, 4-high	28	54	80	4000	600	175–350	d-c	Geared
No. 2 finisher	1 stand, 4-high	28	54	80	4000	600	175–350	d-c	Geared
No. 3 finisher	1 stand, 4-high	28	54	80	4000	600	175–350	d-c	Geared
No. 4 finisher	1 stand, 4-high	28	54	80	4000	600	175–350	d-c	Geared
No. 5 finisher	1 stand, 4-high	28	54	80	2250	600	250–550	d-c	Geared
Tandem cold mill									
No. 1 stand	1 stand, 4-high	20	49	71	2250	600	250–550	d-c	Geared
No. 2 stand	1 stand, 4-high	20	49	71	2250	600	250–550	d-c	Geared
Reel	.....	....	....	....	(2) 125	....	400–1000	d-c	Geared
Single stand mills (two duplicate stands)	1 stand, 4-high	20	49	71	2250	600	250–550	d-c	Geared
Reel	.....	....	....	....	(2) 125	....	400–1000	d-c	Geared
Skin pass mills									
	10 stands, 2-high	32	....	84	1250	6600	360	Induction	Geared
	2 stands, 2-high	32	....	110					



Cold reduction facilities include this two-stand tandemmill and two single-stand ← mills, all 20 in. and 49 in. x 71 in. in size.

Close-up view of the spray piping and control valves for rolling lubricant and roll ↓ coolant on the cold mills.



bution centers. There are also a great many auxiliary switching panels for both 440 volt a-c and 250 volt d-c. There are more than 1000 auxiliary motors operating on the 440 volt a-c and 250 volt d-c systems.

The power required for lighting the buildings is furnished by fifty 75 kva distribution centers. Finishing areas of the plant are provided with fluorescent lights, while the remainder has the conventional high-bay industrial lighting. Outside lighting consists of 80 kw of series fence lighting and 20 kw of series roadway lighting. Complete yard and parking lot lighting is also provided.

Forty-seven overhead traveling cranes, ranging in size from 5 ton to 80 ton, provide excellent facilities for handling product as well as for maintenance work. These cranes are supplemented in strategic spots by jib cranes serving specific operations.

Electric industrial trucks are also widely used for handling the product, approximately 47 being in use. Batteries for these trucks are served by a large automatic battery-charging installation, consisting of four 75 kw motor generator sets, with provisions for adding two more should they be needed in the future.

Plant water, for cooling, washing, flushing, fire protection, etc. is provided from the Spokane River by four 5000 gpm, 90 psi pressure two-stage centrifugal pumps, each driven at 1750 rpm by a 400 hp motor. Two 1500 gpm emergency fire pumps are provided, driven by motor and by stand-by gas engine.

Steam is supplied to the entire plant from a boilerhouse containing three 358 hp water tube boilers operating at 200 psi.

Two 28 in. and 17 in. x 16 in. reciprocating compressors, each driven by an 800 hp motor, supply compressed air throughout the plant.

A complete complement of service shops provide all necessary facilities for maintenance and repair, and includes a machine and welding shop, paint shop, carpenter shop, pipe shop, forge shop, roll shop, etc., all of which jut out at right angles to the hot mill building.

Twelve two-high hand mills provide skin passing facilities, imparting flatness, luster and physical properties to ↑ the sheets.

After being sheared to length, aluminum sheets are given a heat treatment in electrically heated furnaces, in ← order to increase strength and ductility.

Colloidal Oil AS A WAR AND POST-WAR *Fuel*

. . . . a mixture of 40 per cent pulverized coal, 60 per cent fuel oil is advocated by the author as a means of reducing oil consumption . . . . no change in equipment for handling and burning is said to be necessary . . . .

by J. G. Coutant

CONSULTING ENGINEER

NEW YORK, NEW YORK

▲ NATIONAL sufficiency is a prime requisite for the maintenance of service and supplies to armed forces in the time of war. To guard this national sufficiency it is necessary to conserve national skilled labor and to perpetuate mineral resources at all times.

A most important phase of this preparedness is fuel service. Disruption means stopping or slowing up of vital industries and transportation. Therefore fuel means and sources of supply and the transportation and manufacture of fuel preparation and burning apparatus are to be controlled in time of war or peace. Also, in cases where the fuel supply sources fail, it is a function of government to find substitute fuels — preferably those that need no conversion, require no metals, skilled labor, time and money that are so essential in time of stress.

The submarine has seriously interfered with the importation of oil, and has impelled us to draw on our diminishing oil reserves. It will be unfortunate in the next war if oil reserves are depleted and no manufactured liquid fuels are available to take their place.

OIL PRODUCTION IN THE UNITED STATES

The crude oil production of the United States in 1942 totaled 1,385,479,000 barrels, a decline of approximately one per cent from 1941. The daily oil production early in 1943 shows some further reduction of 0.7 per cent below the output of 1942. The continued decline has brought a request from the Petroleum Administrator for the drilling during 1943 of a minimum of 4500 wildcat oil wells, 50 per cent more than ever were drilled in a single year.

The total known underground reserves of petroleum as of December 31st, 1942, was 20,062,793,000 barrels. This means that, at present rate of crude oil production, domestic reserves may last fourteen to fifteen years. It is imperative to find a substitute liquid fuel to guard national sufficiency.

The winter months (1943-1944) will show the vital weakness of the United States to be lack of liquid fuel and means for transportation of both solid and liquid fuels.

It is so necessary in national interest to extend the fuel strength that Senator Joseph C. O'Mahoney of Wyoming, Chairman of the Public Lands and Surveys Committee on War Materials, announced a series of hearings beginning in Washington, D. C., on August 3rd and 4th, to consider his bill S-1243, authorizing the construction and operation of demonstration plants to produce synthetic liquid fuel from coal and other substances to conserve and increase the oil resources of the Nation. Secretary Ickes, the Bureau of Mines and the Petroleum Administration for War presented the need for such fuel and the possibilities of its manufacture, together with the results heretofore achieved in England, Germany and Japan.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943

COAL PRODUCTION IN THE UNITED STATES

Coal production in the United States according to published data has reached a 600,000,000 ton rate per year at the beginning of 1943, a goal that has been attained but not maintained.

Statistics show that coal production dropped steadily from a peak in 1918 to 1939, and in addition much of our coal is handled by equipment that should have been retired years ago because of depreciation or obsolesence. Recognition of this is seen in current talks about reconverting some manufacturing facilities from munitions to mining machinery. This move is well considered, in the face of leaping demands for repair parts. The manufacturers who stopped making repair items will badly cripple the coal industry during the coming winter unless this source of supply is restored immediately. It is equally paramount to provide equipment for the collection of coal dust, and for pulverizing coal.

COLLOIDAL OIL COMPOSITES

The dwindling American petroleum resources, rather than the present rationing, threatens the permanent abandonment of oil as a heating agent. It is a part of a general petroleum curtailment hastened by the war, which can be partially normalized by the manufacture of a substitute oil, made from coal. Fortunately, this can be made by an inexpensive, direct, mass production process in keeping with American standards, in the form of colloidal oil. This is a specification liquid fuel having known higher flame temperature, luminousity and radiant intensity; also a known heating higher value.

The new liquid fuel is a composite of 40 per cent colloidal coal and 60 per cent oil, the economic factors for which may be computed in the following manner:

For example, Bunker "C" No. 6 oil, a residue of the oil refining industry, has been sold as fuel but in recent years has been found rich in constituents for making synthetic rubber and high test gasoline. Such fuel as brought into New York Harbor varies in density and heating value, making it necessary to sell at prices according to its gravity. Bunker "C" No. 6 oil for a 12.9 A.P.I. gravity and less is quoted at $1.65 per barrel (42 gallons) at New York. The following premiums being charged under the O.P.A. schedule 88, amendment 79, effective March 8th, 1943 are to be added to this base price for lower gravity oil (with a corresponding lower heating value): 13 to 15.59 A.P.I. gravity, 12 cents; 16 to 19 A.P.I. gravity, 24 cents (this is an average oil); 20 to 24.9 gravity, 36 cents; and oil of 25 A.P.I. and above, 42 cents.

Taking for our computation an average Bunker "C" oil of 18.9 A.P.I. gravity, a specific gravity 0.94, weighing 7.835 pounds per gallon, the price would be $1.65 plus premium $.24, or $1.89 per barrel.

The heating value is found by the formula for the correlation of calorific value and density:

$$H = 18{,}650 + 40\ (A.P.I. - 10.1)$$

where H = heating value per pound, and A.P.I. = density of oil, degrees A.P.I. This particular oil gives a heating value of 19,002 Btu per pound of oil, or 148,880 Btu per gallon.

The coal for making the colloidal composite is granule of 70 per cent passing 100 mesh screen, has a specific gravity of 1.5 and a heating value of 13,500 Btu per pound. Its analysis is fixed carbon 64.4 per cent, ash 13.2 per cent, sulphur 3.13 per cent, and fusion temperature of ash 2254 F. The present price of this coal at New York harbor is $5.50 per net ton. The data correlated for one gallon of colloidal composite of 60 per cent oil and 40 per cent colloidal coal (by weight) is given in Table I.

TABLE I

	Per cent by weight	Composite weight, lb	Composite volume, gal	Composite heating value, Btu
Bunker "C" 18.9 A.P.I. oil	60	7.835	1	148,880
Coal 1.5 specific gravity	40	5.223	0.417	70,510
Total colloidal composite	100	13.058	1.417	219,390
One gallon of composite		9.215	1	154,830

The substitution of 40 per cent by weight of coal makes a liquid fuel that can be utilized by existing Bunker "C" oil burning systems and burners. The costs of manufacture of colloidal oil from the materials mentioned above are estimated at .044 per gallon, which is increased somewhat by its higher Btu value. (See Table II).

The financial gains in the manufacture of colloidal oil as a New York Harbor project is, at the above prices,

TABLE II

Estimated Cost of Manufacture of Colloidal Oil

Estimated cost of coal — at	$5.50 per net ton
Estimated cost of fuel oil — at	1.89 per bbl (42 gal)
Coal weight per gallon of colloid is 40 per cent of 9.215	3.686 lb
Oil weight per gallon of colloid is 60 per cent of 9.215	5.529 lb
Cost of coal per pound	$.00275
Cost of oil per pound	.005745
Cost of coal per gallon of colloid	$.0101365
Cost of oil per gallon of colloid	.031764
Cost of preparing	.0021
Total cost of one gallon of colloidal oil	$.044 per gallon
Cost of No. 6 — 18.9 A.P.I. fuel oil at N. Y. Harbor	.045 per gallon
Financial gains in cost of manufacture of colloid	.001 per gallon
Financial gains in total Btu	.0005 per gallon
Financial gains in available Btu	.00015 per gallon
Total direct financial gains in manufactured products	$.00165 per gallon

$.049 per barrel. Though the manufacture of colloidal oil would save 47 per cent of the fuel oil, and conserve strategic materials, man-hours and engineering skill required for conversion, from a private investment point of view the financial gains or losses are subject to price control.

The present state of development of colloidal oil manufacture has reached a point where engineers and makers of colloid mills are offering machinery and services for the production of guaranteed specification liquid fuels for composites of 40 per cent to 50 per cent coal and 60 per cent to 50 per cent oil. This new liquid fuel can be utilized by existing fuel oil systems and burners. It offers to many plants the continuous operation which otherwise might be interrupted if it became necessary to convert to coal firing.

TABLE III

Powdered coal price per ton (14,000 Btu per lb)	Colloidal oil 40 per cent coal, 60 per cent oil, price per gallon (154,750 Btu per gal)	Fuel oil price per gallon (148,880 Btu per gal)	Natural gas price per M cu ft (1000 Btu per cu ft)
$ 1	0.55¢	0.53¢	3.57¢
2	1.1	1.06	7.14
3	1.65	1.6	10.71
4	2.2	2.13	14.86
5	2.75	2.66	17.86
6	3.3	3.2	21.43
7	3.85	3.73	25.00
8	4.4	4.25	28.57
9	4.95	4.8	32.14
10	5.5	5.23	35.71
11	5.05	5.86	39.29
12	6.6	6.04	42.86

Table III gives a comparison of cost of different fuels on a total heat unit basis. It offers a quick approximation of prices that may be paid for equal heating effect.

When using this table it is well to keep in mind that many buyers of fuel do not take into account the available heat units when purchasing on a total Btu basis and are not deducting the losses resulting from the combustion of hydrogen that burns to water vapor and carries off in the flue gases the following percentage of the total heat:

3.5 per cent for Eastern bituminous coal
5.6 per cent for colloidal oil
7.0 per cent for fuel oil
11.0 per cent for natural gas.

The burning of colloidal oil is accompanied with other intangible gains that speed-up industrial heating processes. This is because the higher flame temperature, luminosity and radiant intensity reduces the time of heating with a proportional saving in fuel, man-hours, time and plant capital outlay. There is also a further small gain resulting from a smaller quantity of excess air required for complete combustion.

Colloidal oil must not be confounded with the so-called colloidal fuels that are merely mixtures of finely dry-pulverized coal in oil, that are sometimes mixed with a fixative or petising agent. The stabilizing agent slows the separation of particles by gravity. To burn these so-called colloidal fuels ("mixtures of coal in oil") requires special systems and burners.

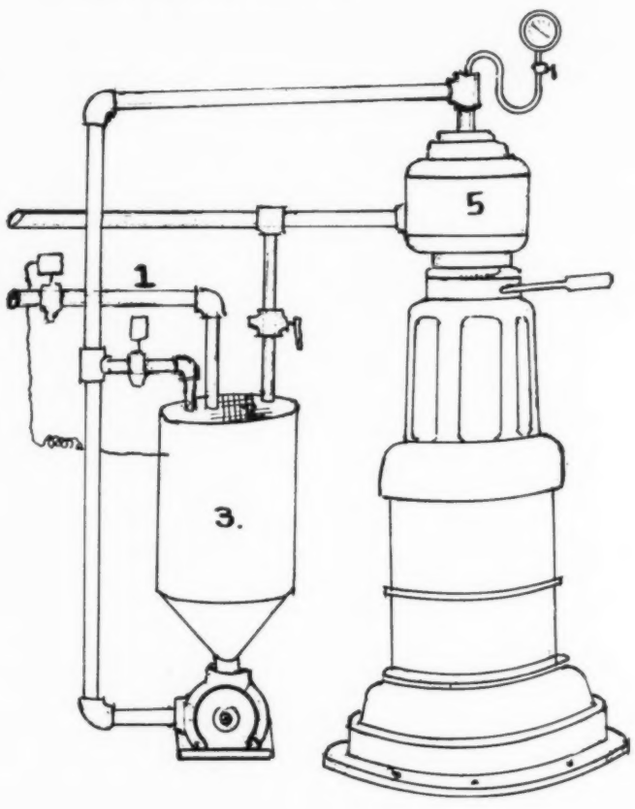
COLLOIDAL FUEL MILL

In the manufacture of colloidal oil to be consumed by existing fuel oil systems, new methods and controls for the colloid mill are necessary. The new methods and controls make possible a colloid that is a composite liquid fuel with smaller size carbon particles which will flow at temperatures and viscosities through pipes and valves, and will atomize by burners the same as the oil previously burned by the system.

The improved colloidal fuel mill is an assembly as shown in Figure 1. Mill operation consists of reducing the coal to a fineness of 60 mesh which is mixed with oil at proper temperature, then it flows through pipe (1) on screen (2) for the removal of iron and other foreign substances before reaching the feed-pump reservoir(3). The feed-pump governs the feed and pressure of the coal-oil mixture to the colloid mill (5) wherein the colloidization, temperatures, pressures and power consumption are automatically controlled to deliver the specified colloidal oil. The new fuel flows like ordinary oil to a cool storage tank from which it is transported, sold, and consumed as though it were fuel oil.

The process of colloidizing coal and oil into a stable liquid fuel has gone through the many stages of development with the colloid mill. The early mills merely prepared colloidal suspensions with tar and creosote as the colloid, then were developed for dispersions of solids and homogenizations. The colloidal fuel mill has passed these various stages, and in order to make true stable composites of 40 per cent colloidal coal and 60 per cent oil without any other agent to make a true fluid substance having a surface tension and cohesion greater

Figure 1 — Sketch indicating principal parts and arrangement of colloidal fuel mill.



than water, it is necessary to reduce the solid coal particle by grinding and final comminution to 35 microns, (450 mesh coal) by internal expansion and simultaneously producing a peptising agent (tar and other coal distillates), these fractionations making penetrating membranes and protective oil globules around coal particles, thus insulating one from the other with a fluid slip that permits the fuel to flow like liquid oil.

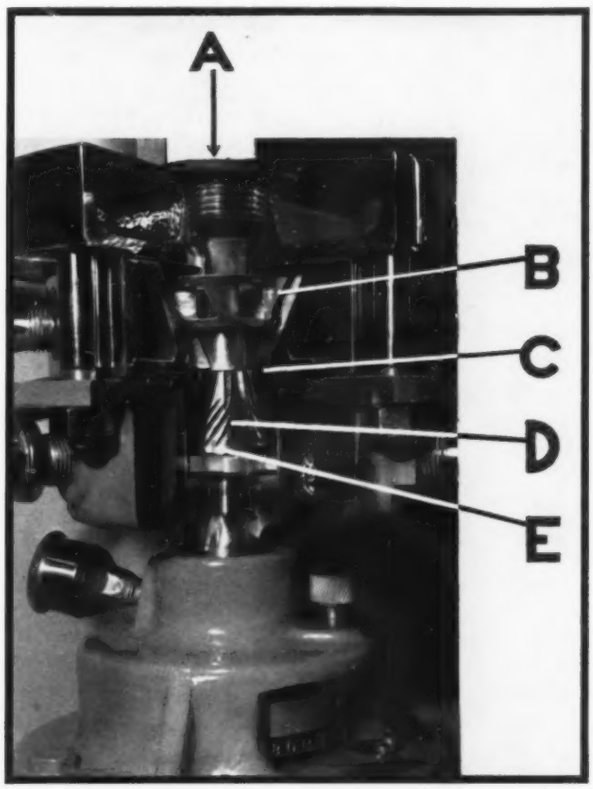


Figure 2 — Mixture of coal and oil enter the mill at A, and flows through rotating mixing element (B) to the toothed rotor, (C-D) and into a carefully controlled gap (E) between smooth surfaces of rotor and stator.

The colloid fuel mill subjects the mixture of coal in oil to proper predetermined pressures and temperatures before entering the colloid mill (Figure 2) at (A) where the top turbine (B) whirls at high velocity impact without separation into positive direct feed to rotor (C). Here it is mechanically sheared by the teeth (D) and both coal particles and oil globules are reduced in size preparatory to entering the space (E) between the rotor and stator. This gap is controlled by a micrometer adjustment (Figure 3) at a distance of .001 to .002 in.

What we call a smooth surface to finish the product would be rough to a fly and is mountainous to the tiny particles and globules. The extremely great surface of particles relative to their mass keep them in a turbulent zone between the nearly stationary films of oil on the rotor and stator — indeed, traveling at four miles per minute in up-and-down currents with varying pressures from zero to hundreds of pounds per sq in.

The reduction in particle size and enormous increase in number of particles, with greater area from grinding by attrition against each other, prevents wear on stator and rotor. The surface area of particles is so large the thinned oil finds it difficult to cover it or to paint the area, thus making a stable, slippery, flowing substitute oil.

COAL COMMINUTION BY INTERNAL EXPANSION

When a solid substance is subjected to external fliud pressure, there is a tendency for the fluid to force its way into such pores or interstices as may be present until the internal pressure is in equilibrium with the external pressure. Even where no visible interstices exist this phenomenon is observed if the pressure is adequate. In some cases there is satisfactory evidence that the fluid is partially dissolved in the solid substance in the course of attaining equilibrium.

The establishment of the high internal pressure in the solid requires time, the actual time depending upon the nature of the solid, the external pressure, temperature, diffusion constant and other properties of the fluid. If the external pressure is suddenly lowered, the fluid within the solid tends to diffuse out the way it entered, but this also requires several seconds or several minutes.

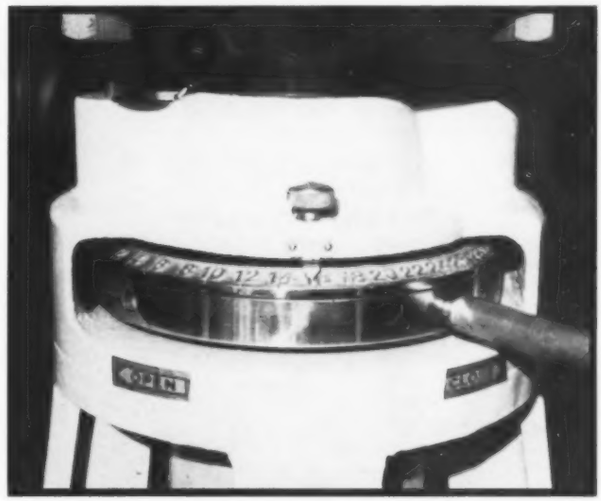


Figure 3 — By means of this micrometer adjustment, the gap between the rotor and stator is controlled to a space of .001-.002 in.

Meanwhile the solid must withstand a great internal pressure not balanced by external forces, or it must burst. Thus, if the proper pressure is applied and then suddenly released, the solid literally explodes into small fragments or powder. It is this principle which is utilized in the explosion method of pulverizing solid fuels that accounts for the low power consumption by the colloidal fuel mill.

COLLOIDAL OIL TRIALS

The Metropolitan Petroleum Corporation, with river, dock, oil storage and distribution plant facilities for the supply of various kinds of oils to retail dealer trucks

serving greater New York, anticipated the serious fuel oil shortage now existing in the city, and some time ago began investigations for the supply of a substitute liquid fuel for the generation of power and heat in the city's fuel burning stations, with a view to helping the small retailers maintain their business and, in doing so, maintain its own fuel services.

These investigations, over a period of months and at the expense of many thousands of dollars, were based on a coal dust and oil mixture with a fixative. It failed to flow and burn in existing fuel oil systems and burners. The trials were observed by a combustion engineer of the U. S. Ordnance, New York Office, who suggested that satisfactory results could be obtained with a true colloidal fuel.

After a review of technical papers concerning the making of a liquid fuel consisting of a coal and oil mixture, and the results obtained, it was concluded at a meeting of cooperative interests to follow the recommendation of the combustion engineer from the Ordnance Department, that of making a true colloidal fuel.

The work was to be a cooperative effort by the Metropolitan Petroleum Corporation, who financed the installation and operation of a colloidal fuel system, the Eppenbach Corporation, who agreed to furnish a colloid mill, with necessary electrical equipment and pump, the Consolidated Edison, who supplied the pulverized coal, and the Colloidal Oil Corporation and U. S. Ordnance who furnished engineering services.

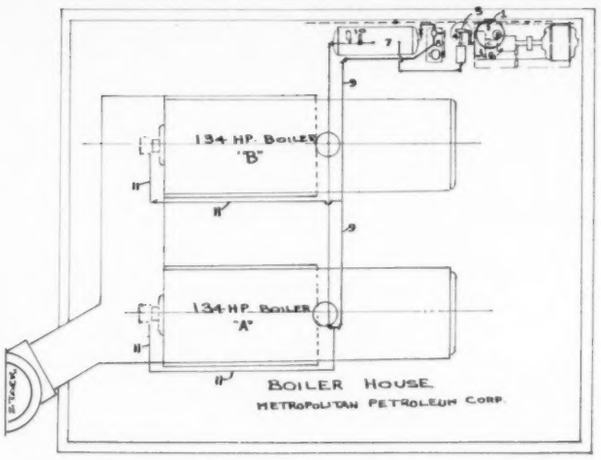
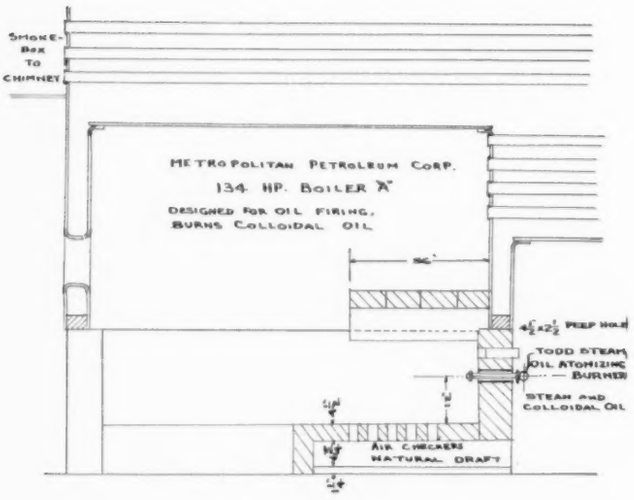
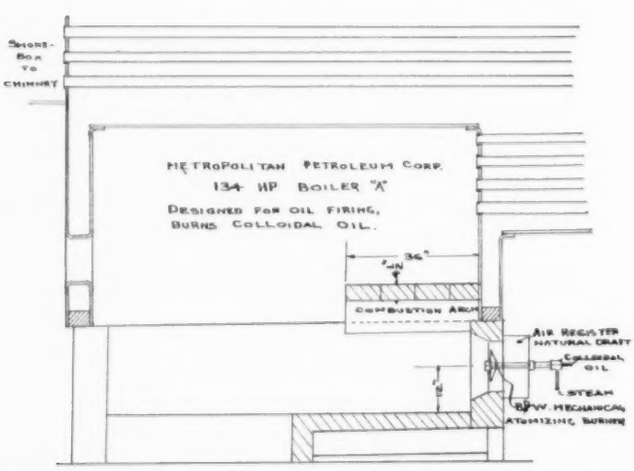


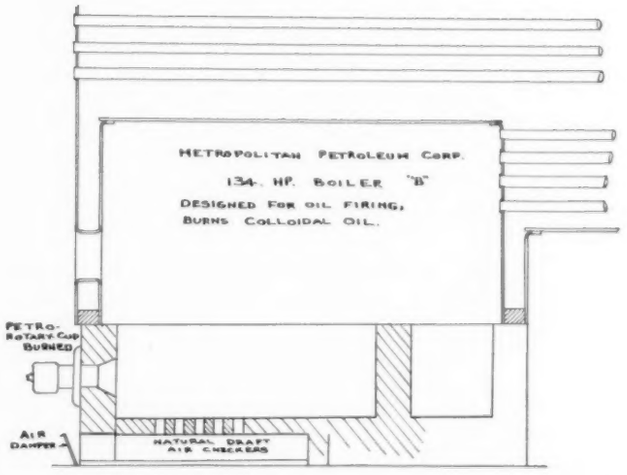
Figure 4 — Plan of boilerhouse used for tests of colloidal fuel, apparatus for which is shown at upper right.

Figure 4 shows the general arrangement of the boiler house and equipment set up for the experiments. Fuel oil was delivered by pipe line (1) that discharged into a graduated coal-oil mixing tank (2) of 55 gallons capacity, and coal, preferably bituminous reduced to a fineness of all through a 30 mesh screen, as may be obtained from any coal mine tipple using a pneumatic dust separation system or from a pulverization plant, was weighed in bags and sifted into the oil in tank (2). A motor driven top-entering propeller-type mixer (3)


SMOKE-BOX TO CHIMNEY
METROPOLITAN PETROLEUM CORP.
134 HP. BOILER "A"
DESIGNED FOR OIL FIRING, BURNS COLLOIDAL OIL
TODD STEAM OIL ATOMIZING BURNER
STEAM AND COLLOIDAL OIL
AIR CHECKERS NATURAL DRAFT

Figures 5, 6 and 7 — Sketches showing burner application and arrangement for colloidal fuel tests.





was used in the open tank (2) to mix the coal and oil. Tank (2) contained steam heating and water cooling coils to provide proper mixing temperature.

The coal-oil mixture then moved by gravity into the colloid mill feed pump tank (4) of 10 gallon capacity. This tank was equipped with a strainer for the removal of foreign substances before flowing by gravity to the motor driven mill feed pump (5).

The motor driven horizontal colloid mill (6) was designed to fill the needs of industry for a mill that would grind fibrous materials, grind hard particles and both grind and emulsify thin materials or paste goods. It had a capacity of 125 to 1,000 gallons per hour.

The colloid mill discharged directly to a 275 gallon storage tank (7) from which the colloidal fuel, with a fluidity equal to oil, flowed into fuel system feed pump.

The colloidal fuel distribution systems were of two types, direct and recirculating, and included a steam

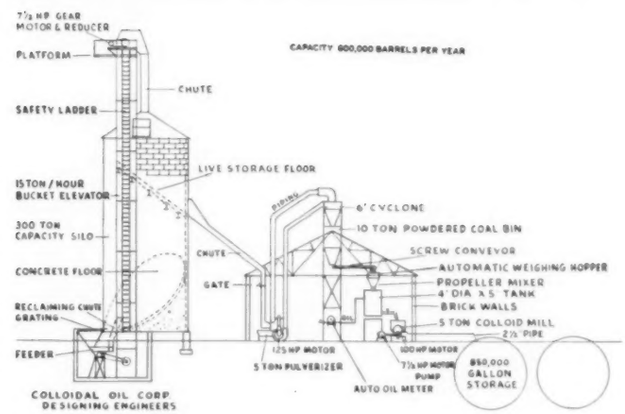


Figure 8 — Proposed arrangement for colloidal oil plant with a capacity of 600,000 barrels per year.

heating coil in the fuel storage tank to heat the colloid fuel to desired temperature. The colloid fuel was taken direct from the bottom of the fuel oil storage tank by the fuel service pump (8). It should be noticed that no settling tank with steam coils was provided between the pump and fuel storage tank. The fuel pump discharged to a recirculating system (9) with a relief valve and thermometer (10) for temperature-pressure control. No pulsating air chamber was provided as is usual with fuel oil systems, yet a steady flame was obtained with the colloidal fuel firing. From the recirculating system, a pipe was connected to a rotary cup burner, simulating a direct system (11).

Trials were made with three types of standard industrial oil burners for the firing of the colloidal fuels:

1. Todd Combustion Equipment, Inc., on boiler "A"
2. Petroleum Heat and Power Corporation, on boiler "A"
3. Babcock and Wilcox Company, Inc., on boiler "A"
4. Petroleum Heat and Power Corporation, on boiler "B"

Figure 5 shows the combustion chamber arrangement of boiler "A" with an arch to simulate an industrial heating furnace within a steam boiler combustion chamber. In this case the Todd Combustion Equipment steam atomizing burner was used without difficulties. Figure 6 shows the combustion arrangement with a B & W mechanical-atomizing oil burner, with air register for natural draft operation, having a capacity of 80 gallons per hour. Figure 7 shows the combustion arrangement with a "Petro" model W-6-H Type 3,000 Petroleum Heat and Power Corporation standard rotary cup oil burner, consisting of burner unit, strainer, relief valve and no-voltage release switch, driven by a 2 hp, 220 volt a-c motor.

During all trials colloidal fuel burned with equal facility as oil, with a better CO_2 and less excess air required than for oil.

Coal mines having modern coal preparation plants, with air tables for dry cleaning ⅜ in. x 50 mesh coal before washing, extract the 50 mesh x 0 coal dust by air drawn through coal by a fan suction system to a cyclone-type dust collector and the dust falls by gravity into large storage bins. It is the practice to blend this valuable prepared dust with the cheapest slack and nut-slack coal. This fuel dust could be used for the manufacture of colloidal oil, thus eliminating pulverizing cost, which amounts to 50 per cent of the cost of the complete colloid process. Steel plants, with large oil storage facilities, piping systems and distribution centers, might well adopt the use of colloidal oil. It is optional whether the colloidizing plant should be located at the steel plant or at the coal mines.

During the winter months of 1943-1944 an acute locomotive fuel problem is likely to result from delays caused by lower grade run of mine, smaller size and dirty coal.

In as much as the quality of coal will continue to decline it is imperative to investigate the future consumption of cheaper, lower grade fuels that burn at higher thermal and commercial economies. In this connection, colloidal oil and powdered coal might well be considered.

The principal advantages to be derived from the burning of colloidal oil is ample fuel feed and rate of combustion to produce the needed steam under all conditions and without standby fuel loss. It is estimated that 15 per cent of the total locomotive coal is consumed in cleaning, maintaining and preparing of fire in engine terminals, in addition to which are standby losses on line of road and a further 8 per cent cinder loss in train service.

COLLOIDAL OIL PLANT

Relative to the type of equipment and initial cost of a colloidal oil plant for a capacity of 600,000 barrels of fuel per year, we have made a diagramatic sketch showing an outline of the equipment needed for a proposed plant (see Figure 8), the capacity and cost of which is estimated as follows:

One 5 ton 30-60 mesh bituminous coal pulverizer	10,000 lb per hr
No. 6 oil	20,000 lb per hr
Three 5-ton colloid mills	30,000 lb per hr
Colloidal oil at 8.5 lb per gal	3,529 gal per hr
Colloidal oil at 42 gal per barrel	84 bbl per hr
Capacity per day:	
Three 5-ton colloid mills	720,000 lb per day
Colloidal oil at 8.5 lb per gal	84,706 gal per day
Colloidal oil at 42 gal per barrel	2,016 bbl per day

Capacity per year:

Three 5-ton colloid mills	216,000,000 lb per year
Colloid oil at 8.5 lb per gal	25,411,800 gal per year
Colloid oil at 42 gal per barrel	604,800 bbl per year

The initial cost of the plant is based on receiving slack bituminous coal from the mines, unloading by a locomotive crane and stocking in yard. Also it is assumed that some present fuel oil storage will be available for storage of colloidal oil.

The approximate estimated cost in three items:

	Yard storage	*Coal pulverizing*	*Colloid*
Catapillar locomotive crane	$12,000	.....	.....
Coal storage and elevator	20,000	.....	.....
Coal pulverizer with motors, etc.		$13,000	.....
20-ton pulverized coal bin, chutes		3,000	.....
Three 9 in. screw conveyors and rotary valves		1,000	.....
Three 1-ton automatic scales		1,500	.....
Three hot oil meters		.....	$ 2,400
Three 400 gallon hot mixers		.....	18,500
Three hot oil mixture piping systems		.....	3,900
Three 5-ton colloid mills with motors, valves, piping, hopper		.....	66,000
Total sum of above, $141,300, excluding land and oil storage.			
Forward			$141,300
Building			15,000
Steam, water and oil piping, sewers			8,000
Electric lighting and motor wiring			9,000
Building excavations and foundations			20,000
Engineering and supervision			25,000
Total initial cost			$218,300

Power consumption:

Coal handling equipment	1	kwhr per ton of colloidal oil
Coal pulverizing equipment	4	kwhr per ton of colloidal oil
Coal oil mixer	1½	kwhr per ton of colloidal oil
Screw conveyors	½	kwhr per ton of colloidal oil
Colloid mills	12	kwhr per ton of colloidal oil
Total power required	19	kwhr per ton of colloidal oil

Fixed costs per ton:	*Per cent*
Interest on money invested	6
Taxes and insurance	2
Workmen's compensation	½
Depreciation, amortization	8
	16½
Total annual fixed charges	$36,970

Plant operation costs per ton, based on 300-24 hour days per year.

	Cents
Fixed charges	33.4
Electric power at ½c per kwhr	9.5
Maintenance	2.
Lubrication	0.005
Miscellaneous supplies	1.3
Labor, three men, each 8 hours, $8 per day	7.
	53.205
Total operating costs per ton	53.205
Total operating costs per gallon	0.226
Total operating costs per barrel	9.49

With these figures at hand it is a simple matter to add the costs of coal and oil to arrive at a unit cost per gallon, barrel or ton.

DISCUSSION

PRESENTED BY

W. P. HILL, Steam Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

J. G. COUTANT, Fuel Engineer, New York, New York

H. C. REESE, Fuel Engineer, Wheeling Steel Corporation, Steubenville, Ohio

J. L. MILLER, Assistant Chief Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

R. I. GUMAER, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

A. J. FISHER, Fuel Engineer, Bethlehem Steel Corporation, Sparrows Point, Maryland

W. P. HILL: I would like to ask a question on the clearance in this mill. Mr. Coutant said it must be from one to two thousandths. What would be the average life of the mill?

J. G. COUTANT: There doesn't seem to be much wear. The faces of the rotor and stator are surfaced with tungsten carbide. We have no figures on the exact life, although one of them has been in operation about eight years.

W. P. HILL: One more question on the slagging of the furnaces using this fuel: what effect does the slagging have on the brick work?

J. G. COUTANT: We know the particle is about one-fifth the size of powdered coal. Then the ash particle is one-fifth as large. Since particles cool in suspension very quickly, the ash problem with these small particles should be very much less. The carbon burns out completely and coalescent slagging does not occur on brick work.

I might say on the ash problem, that in the combustion of powdered coal I could get a higher efficiency in boiler furnaces when I had a coal of high ash content. The flame is shorter, which leads me to believe that what lowers the flame temperature so much in fuel oil firing is the preferential combustion of the different constituents of the fuel oil; when there is a small amount of solid substance present, it acts as a catalyst giving surface combustion and a much higher flame temperature. It is the reason why higher flame temperatures are observed with powdered coal than with oil firing.

It is expected the same is true with colloidal fuel, but not as high flame temperature as powdered coal.

H. C. REESE: In handling coal for either pulverized or colloidal fuel, there is always a certain amount of moisture that gets into your coal. At some plants this runs from 8 to 13 per cent. How would this moisture affect your final product?

J. G. COUTANT: I have always been a stickler for having enough moisture in coal when it is burnt, because tests show that dry oxygen unites with dry carbon, and forms CO. It will not burn with the dry oxygen to CO_2 as a trace of water must be present. Likewise, dry hydrogen, will not unite, unless there is some hydrogen with a little water; then combustion goes on all right. Water causes no difficulty; it is recommended.

In the colloidal mill, water in fuel is not needed, nevertheless a considerable amount of water will always be present. It would make a little difference at the burner, causing sputtering, and a little difficulty in the ignition, but if the furnace is hot enough, these conditions will not be noticed.

H. C. REESE: What is the highest percentage that you feel that you could go to?

J. G. COUTANT: Take any raw coal (bituminous)

just as it comes from a unit pulverizer, and process it. A colloidal paste made with pulverized raw coal and 25 per cent water has been colloidized and burned.

MEMBER: It may be interesting to know that the Bureau of Mines, in connection with the Atlantic Refining Company, made a test of the colloidal fuel at one of the plants in Philadelphia last spring. During that time 30,000 gallons of colloidal fuel was produced and burned very successfully. However this coal was not produced in true suspension as Mr. Coutant has described; rather, it was a simple mixture of pulverized coal as used in pulverized coal equipment, mechanically mixed with fuel oil.

Settling is one of the things that was suspected would be of considerable difficulty. However it was not found to be particularly troublesome. Three batches of coal, one ground 88 per cent through 230 mesh screen, one ground 95 per cent through 230 mesh, and one ground 99 per cent through 230 mesh, were used. Now the 88 per cent did show some considerable settling, but not serious. However the 95 and the 99 per cent reacted very nicely.

J. L. MILLER: Is colloidal fuel being used any place except boilers? I noticed all references were to boilers.

J. G. COUTANT: We have been accustomed to burning heavy fuel oil — 5 to 10 degrees A.P.I. This is similar to colloidal fuel. In Europe they use the word "heavy oil" for tar-oil and colloidal fuel. There was considerable discussion in the past, in 1936-37, between the French and the Germans as to the burning of heavy oil and light oil for metallurgical furnaces. The light oil was like that we are getting now, whereas the Germans were burning a tar mixture, which they put through a colloidal mill. The tar mixture was handled like oil to rotary cup burners and other types of burners on various types of furnaces. This heavy oil sells at higher prices than light oil.

One rotary cup burner in marine service has a capacity of 7000 pounds of this tar-oil per hour. There are no installations in the United States other than one at Berwind-White Coal Mining Company. They are doing some experimental work in collaboration with the Pennsylvania Railroad, but no information as to results has been released.

R. I. GUMAER: Do I understand that 40 per cent coal by weight is the maximum concentration of coal that works satisfactorily?

J. G. COUTANT: No. The reason I have mentioned forty per cent is because it will flow at the same viscosity and the same temperatures in fuel oil systems as bunker "C" oil, so that there will be no change of the system in order to burn it. I have made some that is a fifty-fifty coal and oil composition, it's easier to make and it is a more stable composite. It would require a special fuel system, using burners that would be rather crude for supplying large quantities, as required for open hearth furnaces.

My reason for stating 40 per cent coal by weight is merely to use existing equipment and existing burners without change.

A. J. FISHER: Sometime ago I asked Mr. Coutant if fuel oil could be stabilized by coal mixing to a certain carbon content for use in open hearth furnaces. We all know that from time to time fuel oil does vary. We get light shipments and heavy shipments of oil. Could the fuel oil be stabilized at some fixed carbon content, not 40 per cent, but say five, ten, fifteen or twenty per cent, as the case may warrant, during and over a period of time?

It has been indicated that an increased production of five or ten per cent could be expected by the firing of pitch over fuel oil, and the question on which I would like to have Mr. Coutant give an expression is, does he think that open hearth fuel oil could be stabilized at some carbon effect value.

J. G. COUTANT: Yes. E. W. Clark of the Koppers Company presented a paper some years ago in which he gave the carbon content of pitch at something like 20 per cent. He gave a figure I happen to remember — that fuel oil at seven cents a gallon would equal a value on this pitch of eighteen dollars a ton. I think the hard pitch would not cost anywhere near that at the mills. By making a cold mixture and putting it through a colloidal mill, say fifty-fifty of the pitch and oil you would have 10 per cent fixed carbon. It is possible to stabilize 5, 10, 15 or 20 per cent coal in bunker "C" oil by passing the coal-oil mixture through a colloid mill.

LEVY *Discussion*

(*Continued from page 45*)

the secondary side if it is to be used as a guide in determining the proper current input to the furnace.

In regard to Mr. Shaad's comments, first, on the transformer, we prefer the shell type construction for large furnace transformers for the following reasons:

1. Shell construction lends itself particularly well to bracing the coils against the mechanical stresses of short circuits.
2. In the matter of cooling the coils, in the shell construction, the coils are vertical so that natural circulation of the oil goes on unobstructedly. Uniform cooling of both core and coils is thus obtained.

In regard to the comments made by Mr. Shaad on the air circuit breaker, the principle used in the air circuit breaker of dividing the arc into a large number of small arcs in series also increases the resistance of the arc progressively, the resulting drop being that of the arc drop corresponding to a great many arcs in series, each with its own anode and cathode. This results in final extinction of the current without forcing abrupt changes.

Practically, in furnace service both types of air breakers being used depend on the air blast for efficient interruption of magnetizing currents. Considering then that 90 per cent of the breaker operations are of magnetizing current, we hardly see that a discussion of the principle of arc interruption by stretching the arc will have a great deal of bearing on the matter of surge voltages resulting from breaker operations.

In regard to the comments on regulator operation, it is somewhat difficult to see why the emphasis is placed on instantaneous response to rapidly changing conditions when the motion of the electrode itself connected to the hoist cables and gearing to the motor is so slow. The best we can hope for in the arc furnace regulator is that the electrode be automatically positioned as a result of the average electrical conditions in each phase.

BEDDING AND RECLAIMING

Raw Materials

. . . . in view of results shown by bedding, the practice seems destined to expand in one form or another, for both ore and coking coal . . . .

by A. J. Boynton

A. J. BOYNTON AND COMPANY

CHICAGO, ILLINOIS

▲ EVERY metallurgical process is necessarily based on the assumption that the materials used in processing are of uniform composition, or, at least that these materials vary within limits so narrow that routine provision for overcoming the effects of such variation may successfully be made. It is well known to all practitioners of these processes that excessive variations do occur, either continuously or occasionally, and that much of the cost of processing, including cost due to failure to meet specifications results from these variations.

A case of such variation, so extreme as to require correction was the use in the blast furnace of the iron ores of Lincolnshire, in England. The metallurgical difficulties which attended the use of this ore resulted from the fact that it is a bedded deposit which includes several minerals, each varying from point to point along the face of the pit with respect to composition and also as to percentage of each mineral making up the deposit at any given point. Chemical differences were very wide and physical variations equally so, the ore changing from soft to hard, from fine to lumpy, with significant color differences ranging through brown, green, yellow and pink. The average iron content was about 23 per cent, silica 8 per cent and lime 18 per cent, but the lime may vary from one per cent to 30 per cent, and the insolubles from 4 per cent to 30 per cent.

These variations were so extreme as to be incapable of correction by the usual methods of grading, and the first application to iron ore of the American developed Robins-Messiter system was consequently made in England, where its use was attended with very satisfactory results.*

In the United States the use of bedding as a means of securing uniform composition of ores has been confined until very recently to the non-ferrous industries. A Robins-Messiter system has been in use for many years at the plant of the Phelps-Dodge Company at Douglas, Arizona, operating on copper ores and concentrates. Here, the system has resulted in a practical uniformity of composition in the ores charged to the company's reverberatory smelting furnaces, and in a complete freedom from the variations formerly encountered. The same system has consequently been adopted for use in the large Morenci plant of the same company installed in 1940-1941. Other methods of stockpiling and bedding have been successfully practiced in various localities.

Within the past two years, bedding installations have been made at three western steel plants. These installations are for the handling and beneficiating of the iron ore supply to the blast furnaces. While these installations are too recent to permit any statement of practice figures from which an exact estimate of over-all benefit from bedding may be made, a statement of the principles and practices, and a description of the plant, would seem to be of interest at this time. The subject also gains interest from the probability that the application of bedding to coking coal is a means to uniformity in American blast furnace practice possibly more important than the bedding of ore, since the handling of Lake Superior ore from mine to cars, from

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943

*This installation was described in a paper by W. A. Haven read before the Eastern States Blast Furnace and Coke Association, February 11, 1938.

cars to dock pockets, from dock pocket to cargo hold, from hold to stock pile or cars, and from the latter to blast furnace bins or to further handling, including a possible second stock piling, produces a mixing effect, which, while it falls short of a full degree of accuracy, results in a large scale mixing, and an averaging of composition somewhat similar to that obtained through bedding. No comparable mixing attends the handling of coking coal as usually practiced.

The operation of bedding consists essentially in distributing material along one axis of a pile or bed, the distribution being effected by continuous reciprocating motion, along this axis, of a device for depositing the material at a constant rate. A system which includes a belt conveyor with tripper is typical of the means employed and illustrative of the effect produced. Reclaiming is effected by the removal of material on successive sections transverse to the bedding axis. The section may be vertical or inclined, the essential requirement being that it shall include an equal amount from each traverse of the depositing apparatus, which may be presumed to be a tripper.

A section thus reclaimed will contain the material necessary to constitute a sample of the pile, and if sufficiently well mixed will, in accordance with the laws of sampling, become a sample of the entire pile or bed. It follows that any section will be practically identical in composition with any other, and that all the reclaimed material from the bed will be uniform in composition.

The above is a brief general definition of bedding as applied to metallurgical raw materials. It remains to consider the principles of sampling and their application to the art of bedding, as well as to describe in general the mechanical means which are applicable to the bedding process.

VARIATION IN THE COMPOSITION OF MINERAL

A mineral such as iron ore generally consists of a mechanical mixture of the valuable constituent, as iron oxide, and a gangue mineral or a number of gangue minerals. The mixture may vary with respect to the amount of contained gangue, or with respect to the composition of the gangue. It may vary within the same ore body with respect to the coarseness of mineralization, that is, the maximum particle size which will permit an economical percentage of the mineral to free itself from the gangue.

Any of these variations may occur in any part of a mineral deposit. Study of the deposit and experience in its exploitation may show certain rules of variation to apply locally, so that the top of a geologically bedded deposit may have characteristics differing continuously and more or less uniformly from those at the bottom. Likewise, a deposit due to enrichment or to direct volcanic action may vary in a definite way so that tendencies applying to certain parts of the deposit become well known, and are relied on by the miner as determining the probable composition of the product of the mine.

Similarly, in the case of coal, which is always a bedded deposit, recognizable and predictable variations in composition may characterize different levels in the seam. Also, one part of a mine may produce coal having characteristics which differ from those of the coal in another part, so that as the workings advance the tendency is toward higher ash or sulphur content, or vice versa. Characteristic ash or bone coal seams may occur at a definite height in the seam. There may, also, occur local variations which conform to no evident tendency or trend.

Knowledge on the part of the operators with regard to the peculiarities of the various parts of a deposit which is being exploited makes possible the operation called selective mining. This consists in loading the outgoing material in accordance with one or more of its characteristics, so as to produce either a series of grades into which the product is divided, or a single grade with a composition as nearly uniform as possible.

The cost of the mining operation is very considerably increased by such a selective practice. Where large tonnages are involved, as is almost always the case with iron ore and coking coal, the mining plant is likely to be complicated by additional trackage and additional hauling, dumping and storage equipment. The operation is usually characterized by increased sampling, by the desirability of synchronizing the delivery from certain working places for the sake of combining the product, or of avoiding simultaneous delivery from others, so as to effect a separation. It is necessary to fulfill a double requirement, that of economical movement of material, and that of satisfying metallurgical requirements. Where the objective of selection is the averaging of the output into a single homogenous product, it is often possible to carry out the metallurgical requirements by bedding the mined product. This makes the mining a material moving operation capable of exercising economies not otherwise practicable. In many cases it may be that the cost of mining and bedding is less than that of selective mining, with metallurgical results better than those possible by selective mining alone.

On the other hand, the variations in the composition of the mineral may follow no ascertainable law, and consequently must be considered as occurring by chance. Consequently, the only knowledge of composition available to the consumer of the product, without extensive sampling and analysis, is that the average composition is likely to be the same as that of recent shipments from the same source. The variations in composition may be presumed to occur within limits which have been ascertained to be characteristic, as a result of previous large scale sampling and analysis. The extent and probable character of these variations may be determined by statistical methods.

Even if all desirable information as to composition of smaller lots, such as car loads which make up a total supply, is obtained by sampling and analysis, the information does not, of itself, supply any convenient means for providing a single grade of uniform composition. While it makes possible division for the purpose of further classification, the elimination of variation within each class is not directly accomplished. Such elimination of variation either for one class or more requires means analogous to a batch mixing tank as used under similar circumstances in the processing of liquids. These means are supplied by the system known as bedding which is now practiced in several ways, but always with the same purpose, namely, that in any

given lot of material, variations in chemical composition are averaged, and the material recovered in a condition which is homogeneous with respect to such chemical and physical components as are of interest, including that of physical size.

PRINCIPLES APPLYING TO BEDDING

It is evident that if a bed or pile of material is to eliminate variations in composition and equalize quality, any short increment of length along the bedding axis should show the same composition as any other parallel cross sectional increment of equal length. Each such increment of length is composed of a large number of random samples of the material, and if these random samples are sufficiently well mixed, the increment of length is a true sample of the composition of the pile. The principles applying to bedding and reclaiming are, therefore, closely related to those of sampling.

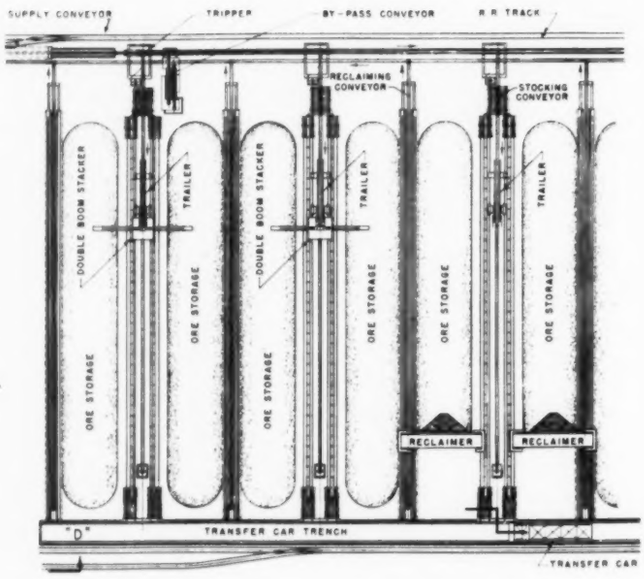


Figure 1 — Plan of ore bedding.

Mechanical sampling requires that the mineral shall be in motion, in order that contact between mineral and sampling device may be effectively made. Two general methods may be followed:

1. That which continuously takes a part of the moving stream of mineral.
2. That which intermittently takes a uniform section of the moving stream. This method is analogous to the sampling principle as applied to bedding. With this method the following principles apply:
   a. The interval between sample cuts should be constant, otherwise all sections along the length of the stream will not be equally represented.
   b. Sample cuts should be frequent enough so that the sample represents the most abrupt change in the character of the stream.
   c. Feed should be constant; if intermittent, no material may be flowing at the time for sampling.

There are many other rules for sampling which do not directly apply to bedding. The above stated principles have an equal application to both.

The application of these sampling methods require the fulfillment of the following general conditions of bedding and reclaiming:

a. The flow of material onto the bedding pile should proceed at a constant rate. It should continue from end to end and from side to side of the pile in accordance with a definite pattern of deposition which should be constant, and applied to each successive layer of material bedded.
b. The accuracy of the bedding operation depends in some measure on the interval, measured by weight of deposited material, between successive depositions at the same spot. The longer the bed, therefore, the more rapid should be the passage of the mineral stream, and the smaller the amount deposited at one passage within any given area.
c. The greater the cross section of the pile, the more traverses of the depositing tripper should be made. The greater the number of traverses in a bed of given cross section, the greater becomes the probability of complete accuracy.
d. The cross section of the bed presents a great number of samples of the material composing the bed. The entire cross section is therefore representative of the average composition of the bed. It remains to mix these various samples in the act of reclaiming.
e. Reclaiming should be done in such a way as to remove an entire cross-section of the bed at one time and to accumulate the material from this cross section on as short a length of the reclaiming belt as possible, with mixture of the cross sectional material from top to bottom and from side to side.

Bedding may be carried on for its metallurgical effect only, or it may be done with the additional purpose of stock piling. In the latter case the size limits of the pile and the number of piles may be determined by considerations of transportation, labor supply, weather conditions and irregular rate of production or of use. Where none of these conditions apply and the object is only beneficiation of quality, determination of the minimum effective size of bed is of interest.

MINIMUM EFFECTIVE SIZE OF BED

The cross section of bed required for effecting uniformity of composition is determined partly by the number of traverses of the tripper in filling the bed, and partly by the economics of material handling, which dictate the width and speed of the delivering belt. The number of traverses determines the number of samples making up a cross section of the bed, while the belt width and speed determines the size of these individual samples. Standard designs of stocker and reclaimer will in some cases decide the cross section of the bed. In such cases the interest lies in determining whether a standard cross section of the pile combined with the desired capacity in the stocking conveyor results in a sufficient number of traverses or samples for effective control.

The answer to this question requires the determination by large scale sampling and analysis of the material which it is proposed to bed. By means of these analyses any given sample may be assigned to one of

several classes, each class having limits of variation narrow enough so that all samples coming within its limits may be considered to be of practically uniform composition. The number of such classes will be determined by the limits of variation in the material.

For example, take a number of determinations of iron content in a series of samples of iron ore, each representing an equal weight of the material. The samples are divided into classes, in accordance with the content of iron, it being assumed that iron is the ingredient of which the variation is sought to be controlled. In the present case each class is presumed to cover a total variation of one per cent, with an average content of iron content in an ore exhibiting the variations as stated, with one per cent as the limit of variation of the bed, a minimum of 218 traverses should be made by the tripper or other depositing means.

If phosphorus is to be taken into consideration, the class limits will be much narrower, say .01 per cent. The same process of sampling and analysis as that outlined above must be carried out, and determination made of the number of samples necessary to include the extreme variations.

The same procedure may be followed for silica or other ingredient which it is desired to control. Evidently one of these ingredients will require more sam-

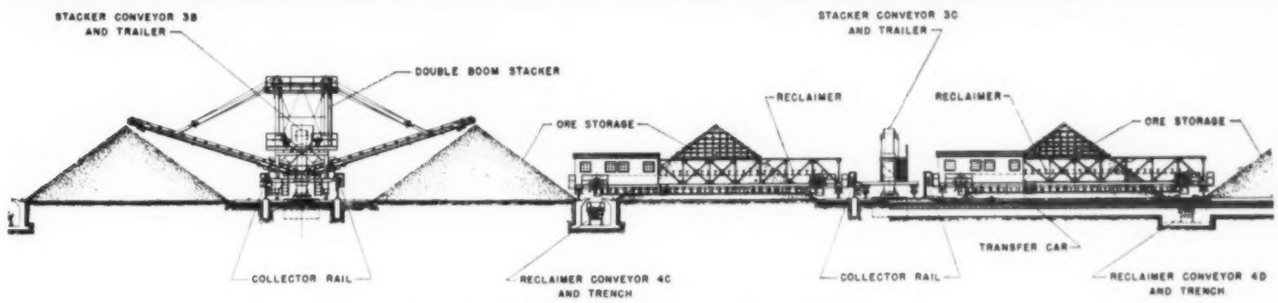


Figure 2 — Section of ore bedding and reclaiming plant.

50 per cent. It is also presumed that variation in iron content within the limit of one per cent is immaterial for operating purposes. The data are set forth in Table 1.

The sampling and resultant classification shown in the table indicate that a sufficient number of samples have been taken to determine the total variation, since four samples each fall into classes 1 and 13 without showing any wider variation. From this table it would appear that 218 traverses, one-fourth the number of samples shown will be adequate for the control sought.

If the required number of traverses has thus been correctly determined, the composition of any deposited unit at any point along the bed will be somewhere within the observed limits of variation. Whatever its

Class No.	Iron content variation from average, per cent	No. of samples	Required number of traverses	Per cent of total
1	+5.5 to +6.5	4	1	.4
2	+4.5 to +5.5	12	3	1.4
3	+3.5 to +4.5	36	9	4.1
4	+2.5 to +3.5	60	15	6.9
5	+1.5 to +2.5	96	24	11.0
6	+ .5 to +1.5	148	37	17.0
7	+ .5 to — .5	176	44	20.2
8	— .5 to —1.5	152	38	17.4
9	—1.5 to —2.5	80	20	9.2
10	—2.5 to —3.5	48	12	5.5
11	—3.5 to —4.5	44	11	5.1
12	—4.5 to —5.5	12	3	1.4
13	—5.5 to —6.5	4	1	.4
		872	218	100.0

composition, such a unit may be placed within one of the thirteen classes listed, and the probability that any unit will fall within any particular class is shown by the percentage figures in the table.

We conclude then, that in bedding for uniformity of ples for this purpose than will the others, and it will be possible to regulate all the ingredients by bedding with a number of traverses equal to the greatest number of samples required by any single ingredient.

The length of the bed is usually a matter of convenience in the handling or use of the material, rather than of accuracy in the control of its composition. This latitude is permissible, because accuracy is but little affected by length, provided the number of traverses is sufficiently great. Where the beds are laid down in parallel, with one bed reclaiming while the other is being filled, a check as to composition is usually made as each bed comes into use. If the conditions existing within the material are those previously described, with no tendency to vary outside the determined limits, and the function of the bedding is consequently to correct local and temporary variations, the composition of one correctly deposited bed will be similar to that of the next. However, a check is always advisable in order to be sure that these conditions are fulfilled, and that no unexpected trend has developed. The greater the capacity of the bed, the less attention to these changes is required.

A concrete example of the circumstances of bedding in installations now in service is shown in the following figures.

Width of bedding pile, feet	58
Height of bedding pile, feet	24.3
Angle of repose of material, degrees	40
Cross section of bed, sq ft	705
Capacity of belt per minute, net tons	13.7
Speed of belt, fpm	250
Speed of tripper, fpm:	
With belt	50
Against belt	100
Average weight material deposited per ft, lb	274

Average cross sectional area of deposited material, sq ft 1.96
Number traverses of tripper to fill pile 360

The figures given indicate that material is being bedded at the rate of 822 net tons per hour.

With regard to the dual speed of tripper it is to be noted that when belt and tripper are moving in the same direction, material corresponding to 200 feet of belt length is deposited in 50 feet, or 4 feet of belt length per foot of pile length. In the other direction 350 feet of belt is discharged in 100 feet, or 3.5 belt feet per pile foot. The ratio of deposited material is 87.5 per cent. This discrepancy arises from the use of a two-speed motor on the tripper, with speed ratio of two to one. A tripper speed of 55 feet instead of 50 feet would practically eliminate the discrepancy.

Reclaiming should be done by simultaneous removal of an equal amount of material from each unit of cross sectional area. Material so recovered will constitute a sample of the bed, in that it contains all the elements which make up the bed in correct proportion to their occurrence. Reclaiming also includes the mixing as completely as possible of all material forming the cross section. Mixing has been well defined as follows:

"Mixing of two or more different materials existing either separately or in an unevenly mixed condition, consists in producing a condition wherein each particle of any one material lies as nearly adjacent as possible to a particle of each of the other materials."

Under the conditions which characterize the operations of the iron industry, effective and practically accurate mixing should be a feature of reclaiming.

ROBINS-MESSITER BEDDING AND RECLAIMING SYSTEM

As previously stated, the pioneer installations for accurate bedding and reclaiming, as required by the copper industry, were of the Robins-Messiter type. These installations as made today include two machines, one for stocking and the other for reclaiming, together with the necessary belt conveyors, transfer cars for stocker and reclaimer and other auxiliaries. The operation is in batches, and the beds are made and used in pairs, one bed being stocked while the other is reclaimed. A plan of the essential features of such an installation is shown in Figure 1. The ore comes by belt from a source of supply and is tripped onto the stocking belt, since existing installations all include more than one stocking and reclaiming unit. The tripper permits the deposition of ore onto any stocking belt. The stocking belts run between each pair of beds. The stocker spans this belt and runs on rails. The stocking tripper runs on the same track and is detachable from the stocker. This arrangement permits one stocker to be transferred to any stocking track, by means of the transfer car, which may also transfer the reclaimer from one reclaiming track to another. So long as only one unit of each kind works at a time, duplication is necessary only as a matter of spare capacity.

The stocking tripper which is shown on Figure 3 delivers to receiving and feeding equipment on the stocker, and the material is delivered to the bed by either of two short boom conveyors, which may be raised and lowered at will. Stocker and tripper are connected and travel together to and fro on the stocking track. The general shape of the stocker is shown in Figure 2.

This figure and also Figure 4 show the reclaiming machine, which is the most completely original mechanical feature of the system. This machine consists essentially of a carriage running on rails which extend along either side of the pile. This carriage is self propelled in a direction longitudinal of the pile, and travels at an adjustable rate of a few inches per minute, corresponding to the rate of reclamation. The reclaimed ore is carried to one side by a metallic conveyor equipped at regular intervals with plow-shaped members which move the ore away from the toe of the pile and then to the point where it is discharged onto a longitudinal conveyor running in a trench below the yard level. This conveyor discharges onto the main reclaiming conveyor. In order to produce an equal flow from all parts of the cross section, and to secure exact and accurate mixing a harrow is provided. This device is secured to the carriage at the bottom and is free to rotate vertically about its axis of attachment to the carriage. The angle which the harrow makes with the vertical is determined by a cable supporting it at the top. This angle should be a little steeper than the angle of repose of the material, and may be varied if this angle changes. Carried on the frame of the harrow are a large number of steel teeth pointing into the pile. The harrow is reciprocated horizontally and the steel points scratch the surface of the pile at 432 points spaced at about eight inch intervals. The result is an even flow of material per square foot of cross sectional area, across the entire bed and from top to bottom. In the meantime the whole assembly moves toward the bed and keeps the harrow teeth engaged. The harrow makes about 16 strokes per minute; the strokes are 24 inches long. The maximum time required for descent of material from the top of the pile to the conveyor is a few seconds; the speed of the conveyor is about 85 feet per minute. Material which mixes on the conveyor is taken from a face which, due to lapse of time, is slightly skewed from the transverse axis of the bed, the skew being a resultant of the relative speeds of the machine along the track and of the speed of the conveyor, about 3 inches in 58 feet. This skew does not represent an error, since it persists and is constant. Any short increment of length of the conveyor therefore contains a thoroughly mixed sample representing the entire cross section of the bed. Figure 5 shows a stocker and reclaimer in the ore yard of the Fontana plant of the Henry J. Kaiser Company, Inc., at Fontana, California.

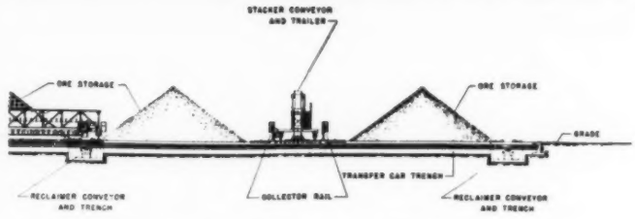


Figure 3 — Section of ore bedding plant.

This system is particularly adapted to ores which are somewhat sticky and which would flow in an uneven way if brought down by gravity alone. As now built, it is limited to crushed material, four or five inches in size. The machine does not dig and merely removes the material brought down by the harrow.

With regard to winter weather we believe that the working face may require to be worked continuously or at short intervals in order to keep it open. A crust may form along the edges of the cross section, and at the ends of the pile, and this crust may require to be thawed. Experience to date is limited to localities where the climate is milder than in the northern states. With fairly dry and lumpy ore, ordinary winter weather presents little difficulty.

The operation of bedding by this system has been required in connection with the use of sized ore, and the question has arisen as to whether the sizing should be done before bedding or after reclaiming. In my opinion, there are several reasons for preferring to bed first:

1. The metallurgical results will be the same in either case; that is, a true average of composition will be obtained and the proportion of various sizes will be made constant throughout the bed, while size segregation, which occurs in bedding, is corrected in reclaiming.
2. Degradation due to handling is taken care of by subsequent screening.
3. The physical character of a run-of-crusher ore makes it much easier handled under conditions resulting from moisture and frost.

Figure 4 — Reclaiming machine.

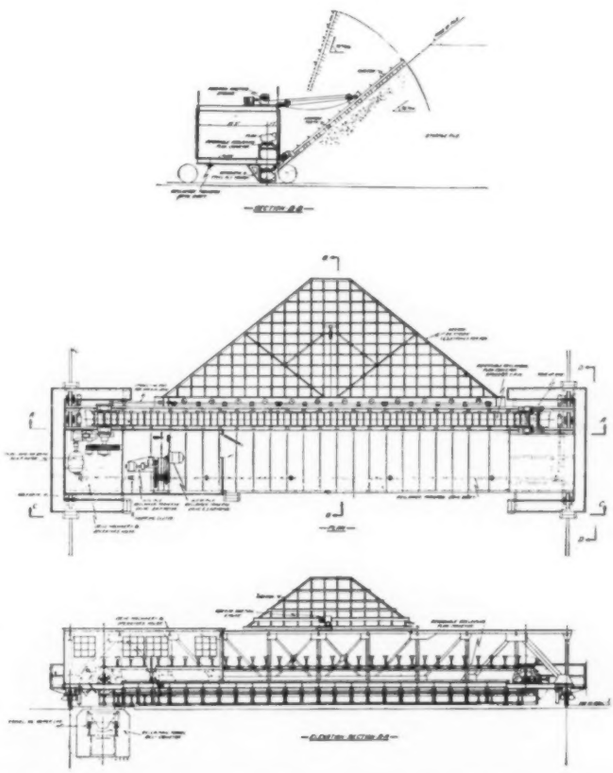


Figure 5 — Stocker and reclaimer in ore yard.

4. Finally, the number of beds necessary to provide is divided by a figure corresponding to the number of sizes, and is at least halved.

The amount of iron ore which may be stocked with one stocker as now designed will run nearly one thousand tons per hour. A reclaimer will handle 450 tons in accordance with design figures, but its actual capacity is nearly 600 tons. It will be possible to design for considerably greater tonnages.

The Robins-Messiter system has shown itself capable of producing a practically perfect technical result, and to be convenient and economical in operation. The batch system enables a bed of 10,000 to 15,000 tons or more to be laid down and its composition determined before use.

Any variation in composition from that of the previous bed may be compensated by an adjustment of the relations of ore, fuel or flux, and the volume of the bed may be such that these adjustments are not too frequent.

OTHER POSSIBLE METHODS

There are many situations in which it is desirable to secure uniformity of composition, but often the rate of handling, or the amount or kind of material to be stocked, is unsuitable, or the climatic conditions are too severe to permit the use of the system just described. This has been recognized and bedding by other methods has been practiced. Among these methods may be mentioned that of bedding by low level conveyor discharging onto a stocker in the form of a revolving yard crane with bedding conveyor running along the boom. By rotating the crane and raising and lowering the boom between traverses of the crane alongside the bed, it becomes possible to deposit material in parallel windrows, with each successive layer filling the hollows between the windrows of the previous one, and so to build up a bed in which size segregation is confined within each unit of material deposited. In the absence of a reclaimer which provides complete mixing, such a method of deposition is necessary to prevent size segregation in the reclaimed material. Reclamation is by power shovel, or other convenient form of loader, with delivery into railroad cars standing on a track alongside the bed, either directly or by means of a short conveyor belt. With this method, and with the loader

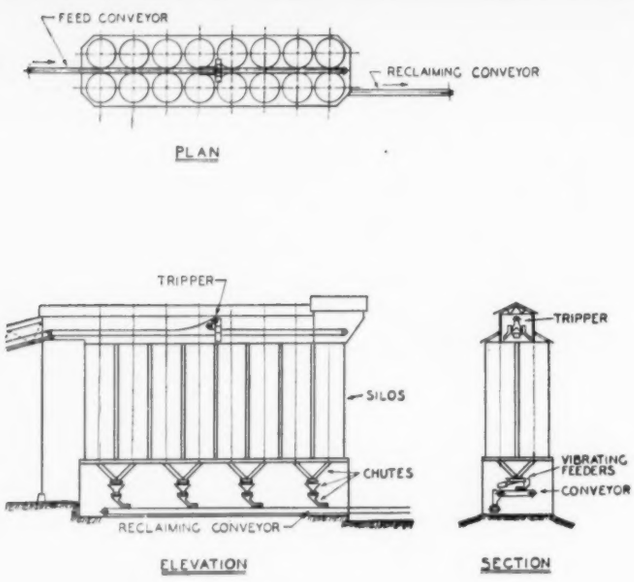


Figure 6 — Silo bedding system.

handling sufficient material from one place to make the loading economical, a car load or more of material will be loaded in completing a reclamation from a complete cross section of the pile. Such a cross section will make up a true sample, but mixing is defective. Whether such mixing is sufficient will depend on the circumstancex of use and the size of the unit charged in the metallurgical process which follows. At best these results are technically inferior to those obtainable with the Messiter reclaimer.

Silo systems, as shown in Figure 6 are often used to control the quality of material. Two methods of operation may be practiced. In one, the tripper moves continuously from one end of the system to the other, in general as already described. When one side of the system has been filled, reclaiming is effected by emptying the silos in series, from one end of the system to the other, while the parallel row is being filled. This method is an attempt to follow the principles already outlined. It falls short of fulfilling these requirements because no mixing takes place in the individual silo in the process of reclaiming, excepting such as is due to more rapid descent of material directly over the outlet than at other points on the horizontal cross section. The material comes out for the most part in the same order in which it went in, and, although the method is in general accord with the principles of bedding and reclaiming, the lack of mixing in the latter phase results in a uniformity far short of that secured where mixing is complete.

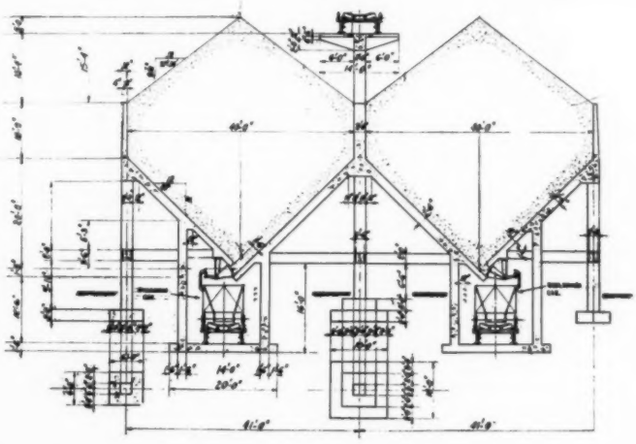
In the second method of operation the silos are filled in series and emptied in parallel. The effect is generally similar to the other method, the relative accuracy depending on the number and height of the silos. With the second method each silo is filled practically without mixing and the only mixing is that effected during reclaiming by combining a number of streams corresponding to the number of outlets from the silos. These outlets are too few to result in a well averaged composition.

This second method will give a good result if the material going into each silo may be considered homogeneous, and regulation of the rate of reclamation from each silo is practiced so as to proportion the material from each outlet as desired. This is not bedding in the true sense, since no presumption of homogeneity is made in bedding practice.

Bedding may be carried on in pairs of bins instead of in piles. If the bins contain transverse partitions, the effect will be similar to that produced by bedding in silos. If however, there are no such partitions bedding of certain freely flowing materials as coal and sandy or pebbly ores may be successfully done, with reclaiming by the force of gravity acting along the natural slope of the material.

The two bins lie parallel as shown in Figure 7, and may be filled alternately by a single belt and a tripper fitted with a transverse reversing belt. A bed may be formed within either of these bins exactly as in the bedding pile. Withdrawal at any time will be from a single point along the bottom which will advance gradually from end to end of the bin. There will be a section at each end of the bin where material cannot be withdrawn by movement along its natural slope and

Figure 7 — Cross-section through bin bedding system.



where, consequently, material cannot be withdrawn uniformly throughout the height of the pile. For this reason the full length of the bin should not be used. Filling should be so done that the toe of the pile reaches one end of the bin. At the other end a sloping pile of material reaching the end of the bin at its top should be left permanently in place.

Between these points stocking should be done with reclamation through a continuous succession of gates extending along the bin bottom. Flow will be down the natural angle of repose. Reclaiming may be by belt running the length of the bin as shown in Figure 7. The reclaiming car, which is also shown, is a self propelled hopper, carrying means for successively opening and closing the bin gates and diverting the flow onto the belt. This car is also designed to take care of a surge of material on the slope and to avoid spillage.

This bin system operates in a manner similar in principle to the first described system, in that the beds

are filled by reciprocating tripper and reclaiming is along transverse sections of the bed. Its applicability depends on the material to be bedded. With rocky or pebbly ore or coal, material having the characteristics of a semi-fluid, this system will give good mixing and a good degree of uniformity. The less fluid the material, the thicker will be the thin streams in which the material flows down the face of the pile, and the less complete will be the mixing.

This system, in its general features, has been successfully used by various operations concentrating, smelting or refining non-ferrous ores or metals.

For use in the iron industry such a method of bedding will apply chiefly to coking coal. The two factors which determine its applicability are, first, the rate of stocking and reclaiming, and, second, the bedding unit, or weight of material making up a single bed. A high rate of operation makes a gravitational method of handling relatively attractive. The cost of the bin system is determined by the bedding unit. The size of this unit is arbitrarily determined in accordance with rate of use, cycle of operations, cost of installation and possibly other considerations.

CONTINUOUS BEDDING

While bedding has usually been considered a batch process, carried on in two beds, with alternate stocking and reclaiming, there are many circumstances which permit all the objects of bedding to be obtained by continuous stocking and reclaiming in a single bed. For example, where a mineral is being produced, which shows no trend toward progressive variation, but shows the same average composition day after day, it may still be subject to local and temporary differences which result in occasional wide variations from average quality. These may be overcome and quality made uniform by providing a mass of material large enough to absorb these variations, and adding to it continuously, while at the same time withdrawing at the same rate and in accordance with the laws of bedding. For example, a coal mine working numerous faces may produce as many qualities of coal as there are working faces. A binful of coal large enough to represent a day's work and to show an amount from each working face or each section of the mine, which corresponds to the actual proportions produced in that location, may be taken as the bedding unit. If material is added and withdrawn in accordance with the laws of bedding each increment of material reclaimed will be a sample of all the material in the bin, and will be constant in quality, excepting as the general average of quality varies from time to time.

In order to carry on this method it is necessary to bed along a plane which makes a vertical angle with the angle of reclaiming. If stocking is done by a reciprocating tripper, and reclamation is carried on simultaneously and in equal amounts for each unit of length of the system, each short unit of length of the reclaiming conveyor will carry a correct sample of the total amount of material within the bin.

This method has been successfully applied, so far as its general principles are concerned, in a 7000 ton bin in which coking coal has been continuously bedded with satisfactory results as to uniformity. In this system bedding was done along a horizontal plane and reclaiming along a plane inclined to the first. A number of gates at different levels were used in parallel to reclaim the coal. The primary object was equalization of sulphur content.

This method may be developed to show a high degree of accuracy and a minimum of cost. It is best adapted to situations in which a large tonnage must be handled. Construction is reduced to a minimum by building the bin low at one end and high at the other, thus filling the bin from one end to the other, along the bedding angle and reclaiming along a horizontal plane.

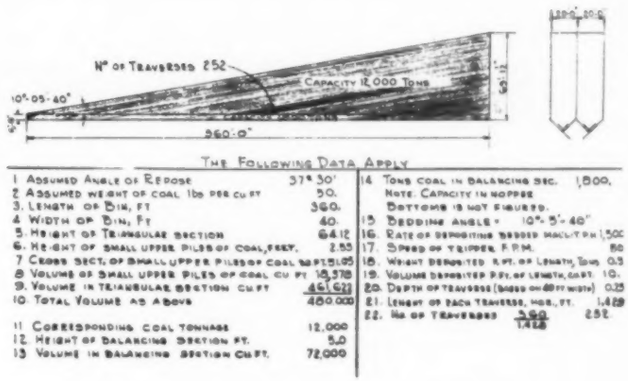

N° OF TRAVERSES 252
CAPACITY 12,000 TONS
10°-05'-40"
360'-0"
THE FOLLOWING DATA APPLY
1 ASSUMED ANGLE OF REPOSE 37° 30'
2 ASSUMED WEIGHT OF COAL lbs PER CU FT 50.
3 LENGTH OF BIN, FT 360.
4 WIDTH OF BIN, FT 40.
5 HEIGHT OF TRIANGULAR SECTION 64.12
6 HEIGHT OF SMALL UPPER PILES OF COAL, FEET. 2.55
7 CROSS SECT. OF SMALL UPPER PILES OF COAL SQ FT 5105
8 VOLUME OF SMALL UPPER PILES OF COAL CU FT 18,378
9 VOLUME IN TRIANGULAR SECTION CU FT 461,622
10 TOTAL VOLUME AS ABOVE 480,000
11 CORRESPONDING COAL TONNAGE 12,000
12 HEIGHT OF BALANCING SECTION FT. 5.0
13 VOLUME IN BALANCING SECTION CU FT. 72,000
14 TONS COAL IN BALANCING SEC. 1,800.
NOTE. CAPACITY IN HOPPER BOTTOMS IS NOT FIGURED.
15 BEDDING ANGLE = 10°-5'-40"
16 RATE OF DEPOSITING BEDDED MATERIAL PER HR 1,500
17 SPEED OF TRIPPER, F.P.M. 80
18 WEIGHT DEPOSITED P.FT. OF LENGTH, TONS 0.3
19 VOLUME DEPOSITED P.FT. OF LENGTH, CU FT. 10.
20 DEPTH OF TRAVERSE (BASED ON 40 FT WIDTH) 0.25
21 LENGTH OF EACH TRAVERSE, HOR., FT. 1.428
22 NO OF TRAVERSES 360 / 1.428 = 252

Figure 8 — Design data for coal bedding plant.

This system is reduced to a concrete example in Figure 8, in which the quantities shown correspond to an hourly coal tonnage of 1500, with a bedding unit of 12,000 tons. The height and length of the bin are determined in part by mechanical considerations, in part by the desired bedding unit and in part by the conclusion that 252 traverses, as shown, will be sufficient to reconcile the variation in quality. This last conclusion is reached by the method previously described. It will be seen that the horizontal line along the base of the triangle intersects every traverse made by the tripper in depositing material within the bin, from the earliest to the most recent. Continual removal in equal amounts per unit of length will result in uniformity of composition of material deposited on the reclaiming belt below. Reclamation must be at the same general rate as bedding and in order to avoid continual adjustment of the rate of reclamation a come-and-go section should be provided. This is shown in Figure 8 as five feet high and containing 1800 tons.

In a system of this size a considerable width is necessary. In the system shown in Figure 8, this width is 40 feet and is so shown in Figure 9. Stocking and reclaiming along the center line of a compartment 20 feet wide will lead to a considerable variation from a uniform down flow across the 20 feet width. This variation may be for the most part avoided by bringing the main flow to the high end of the bin and dividing it into two parts each discharging onto one of two downward conveyors with trippers which carry means of further subdividing the two flows. Figure 9 shows this further division into three equal parts in each compartment.

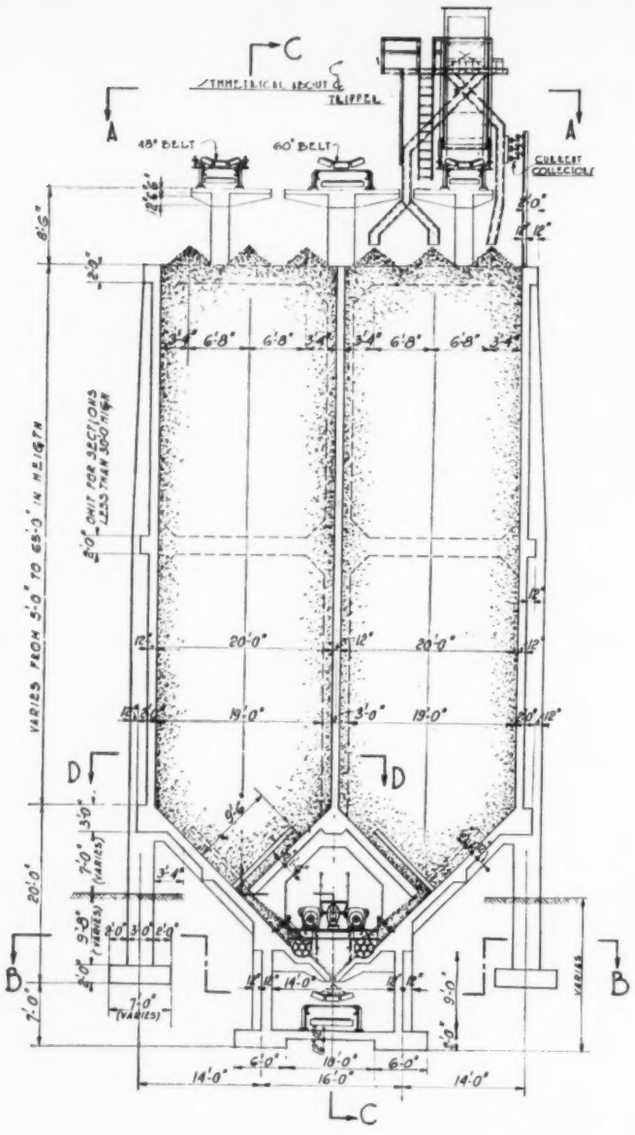
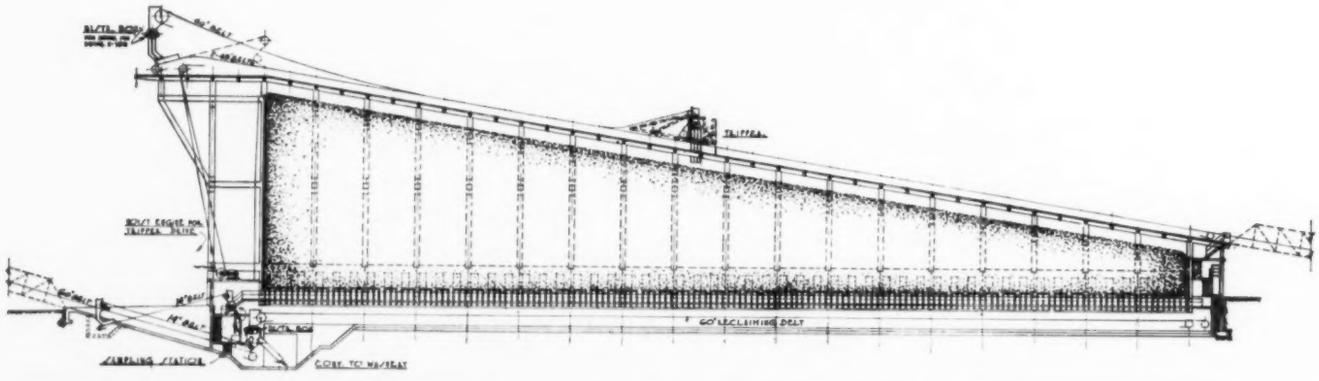


Figure 9 — Typical cross-section through bedding bins for coal.

▲

Figure 10 — Section through coal bedding bin (C-C, Figure 9).



At the base of the bin, outlets may be arranged so that withdrawal takes place directly beneath each of the three lines of stocking. Each outlet port may be individually controlled, for the sake of equalizing the flow from all the outlets, but in general, a single control actuating the continuous star feeders shown in Figure 9 gives a constant rate of flow from end to end of the system. These feeders discharge the contents of the bin onto the reclaiming belt shown in Figure 10. The reclaiming belt in each foot of its length accumulates an equal amount of coal from each outlet throughout the length of the bin. When it reaches the end it has accumulated a correct sample of the contents of the bin. Periodical samples may be taken from the belt by a mechanical sampler. In order to shorten the trippers they face down hill and if two are used they may be handled in balance on a cable, thus averaging variations occurring within the length of a traverse.

INTERMITTENT STOCKING AND RECLAIMING

A system of the kind just described may be used for intermittent stocking and reclaiming. In order to do this the come-and-go section shown in Figure 8 is increased in height in accordance with the length of the period during which stocking is discontinued. An interesting possibility is the use of a system of this kind as the coal bin at by-product coke plants. In this case the come-and-go section may be increased for a possible 16 hour idle period of the stocking operation. The reclaiming feeders and conveyor may be started and stopped as required, the reclaiming belt discharging into the oven larry car. By these means local and temporary variations in the composition of the coal may be eliminated, and size segregation subsequent to bedding may be minimized.

The applications of bedding principles which have been described have in most cases been successfully carried out. Other applications, notably that to large stockpiles of coking coal at the point of use remain to be worked out in detail. In view of the results thus far obtained it seems likely that bedding practices in one form or another will very greatly increase and that they will prove an important contribution to the satisfaction of the increasing demand for improved quality of metallurgical product.

CARBON DIOXIDE *Fire Protection* IN THE STEEL INDUSTRY

. . . . the author sets forth the application of carbon dioxide for fire protection and outlines a number of steel plant installations . . . .

by C. A. Getz

DIRECTOR, RESEARCH DIVISION

CARDOX CORPORATION

CHICAGO, ILLINOIS

▲ CARBON dioxide has been used for many years as a fire extinguishing medium. Nearly everyone is familiar with the high-pressure cylinder type system. In this system, liquid carbon dioxide is stored in high-pressure cylinders that are made strong enough to operate up to an 1800 psi working pressure. These high-pressure cylinders are usually filled to 68 per cent by weight of the amount of water they will hold at 39.2 F (point of maximum density of water). Naturally, the internal pressure developed by the carbon dioxide varies with the temperature. Cylinders normally filled will develop 1800 to 2000 psi internal pressure at 120 F. At this point the safety disc shears, releasing all of the carbon dioxide. When a normally filled cylinder is stored at 72 F, the pressure is 850 psi. As the temperature is raised, the density of the liquid phase and the vapor phase approach one another. At about 88 F, the critical temperature is reached, above which temperature the liquid phase of carbon dioxide does not exist.

This high-pressure carbon dioxide is used in fixed systems as well as in portable equipment. In fixed systems, one or more cylinders, usually of 50 pounds capacity, are used. If more than one cylinder is used, they are manifolded together and piped to the hazard they are protecting. Usually each cylinder has a disc type valve. This disc is mechanically ruptured to release the carbon dioxide. Dip tubes connect these rupture-disc valves to the bottom of the cylinder so that if the storage temperature is below 88 F, liquid carbon dioxide will be discharged immediately.

There are two types of high-pressure portable units, those on wheels and those carried by hand. These are primarily used to extinguish small fires by local direct application. A horn-type nozzle is used to direct the mixture of carbon dioxide snow and vapor at a low velocity onto the fire. The per cent of carbon dioxide snow present in the discharged mixture depends upon the temperature of the liquid in the cylinder. If the cylinder temperature is 70 F, the discharge will contain about 29 per cent "snow"; if the temperature is 86 F, then the discharged mixture will contain about 21 per cent "snow."

LOW-PRESSURE LIQUID CARBON DIOXIDE

Recently, low-pressure liquid carbon dioxide was developed for use in fire extinguishing. Liquid carbon dioxide is maintained at approximately zero degrees Fahrenheit by means of mechanical refrigeration. At this temperature, the pressure developed is about 300 psi. Since the temperature and pressure are controlled to this low value, the pressure vessels are designed for 325 psi working pressure. Because of this low working pressure, large diameter pressure vessels can be used and yet have relatively thin walls. These vessels can be filled to 101 per cent by weight of the amount of water they will hold at 39.2 F (point of maximum density of water). This increase from 68 per cent filling for high-pressure cylinders to 101 per cent filling for low-pressure carbon dioxide vessels is possible because of the much greater density of low-pressure liquid and because of the controlled temperature.

These low-pressure liquid carbon dioxide storage vessels are insulated with efficient thermal insulating material. Therefore, the rate at which heat enters the

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tank is very low and only a small mechanical refrigerator is required to maintain constant temperature. This refrigerating equipment is turned on automatically when the entering heat raises the pressure to about 305 psi and turns off automatically when enough heat has been removed to lower the pressure to about 295 psi. The tanks are equipped with a manometer-type liquid level gauge. Appropriate pressure relief valves and safety discs are also a part of the tank assembly. Storage units of this type are in service in capacities ranging 500 lb to 125 tons. A typical storage tank assembly is shown as Figure 1.

PROPERTIES OF LOW-PRESSURE LIQUID CARBON DIOXIDE

It was pointed out above that low-pressure liquid carbon dioxide is very dense as compared to high-pressure liquid carbon dioxide at its normal temperature range of from 70 F to 88 F. This great density, coupled with constant temperature control, makes it possible to store large quantities in relatively small tanks. Although this is an important point, there are other considerations that are still more important.

Low-pressure liquid carbon dioxide has enhanced fire extinguishing properties. In the first place, it has uniform properties regardless of surrounding temperatures since it is held at constant temperature. The constant temperature and pressure results in constant discharge rates — not changing with weather conditions.

Most people say that carbon dioxide puts out a fire by smothering. If one looks deeper into the situation, it becomes apparent that the fire is actually "cooled out." For example, if one has a gasoline fire burning in a room, hot gasoline vapors come in contact with hot air which contains about 20 per cent oxygen. The oxygen combines, at this high temperature, with the carbon and hydrogen present, giving off heat. carbon dioxide and water. This may be written in the following manner:

$$C_xH_y+O_2=CO_2+H_2O+\text{Heat}$$

The heat created heats up more gasoline vapors and more air, which combine, etc. If carbon dioxide is added to the air until the oxygen concentration is reduced to about 14 per cent, the fire goes out. Why? There is still a lot of oxygen present, 14 per cent. The fire goes out because the heat created is no longer great enough to heat up the gasoline vapors and the mixture of 14 per cent oxygen, 30 per cent carbon dioxide, and 56 per cent nitrogen to the temperature at which they will react rapidly or burn. In other words, the heat that must be absorbed by the gasoline, oxygen, nitrogen and carbon dioxide is greater than that created by the burning action and the fire is "cooled out." If a high temperature is maintained by means of an electric heating element for example, the fuel vapors and the oxygen will continue to combine or burn.

Let us compare high-pressure and low-pressure carbon dioxide with regard to their respective cooling capacities. If one pound of high-pressure liquid carbon dioxide is released, (stored at 86 F) it will form a mixture of carbon dioxide snow and vapor at a temperature of −110 F. To convert this one-pound mixture, consisting of 21 per cent "snow" and 79 per cent vapor, to vapor at +100 F, it is necessary to supply 50 Btu of heat.

One pound of low-pressure liquid carbon dioxide, upon release, forms 45 per cent "snow" and 55 per cent vapor at −110 F. To convert this to vapor at +100 F, 150 Btu of heat must be added. Thus we observe that, under the conditions chosen, low-pressure liquid carbon dioxide has three times the cooling capacity of high-pressure liquid carbon dioxide.

It has been shown that extinguishment of fire by means of carbon dioxide is a cooling action. Further, it has been pointed out that low-pressure carbon dioxide has a much higher cooling capacity than high-pressure carbon dioxide. The fact that the release of low-pressure liquid carbon dioxide results in a very high yield of

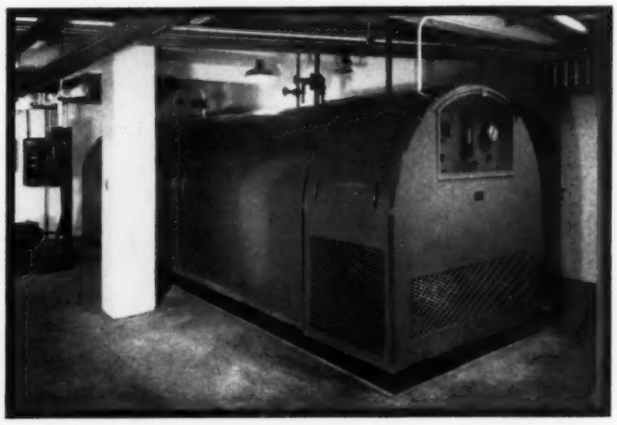

Figure 1 — Typical low pressure liquid carbon dioxide storage unit of 8 tons capacity.

carbon dioxide "snow" has considerable importance over and above the cooling capacity just stressed above. This increase in the amount of "snow" formed is of great importance in connection with local, direct application fire extinguishment. Carbon dioxide "snow" is about 550 times heavier than gaseous carbon dioxide per unit volume at −110 F. This means that a cubic foot of the mixture of carbon dioxide "snow" and vapor formed upon the discharge of low-pressure liquid carbon dioxide is considerably heavier than the mixture formed upon discharging high-pressure liquid carbon dioxide. Consequently, it is possible to project the discharged mixture for a greater distance, even in the presence of a strong draft caused by a large fire and/or natural wind currents. One might compare this to throwing a handfull of buckshot across wind in contrast to the throwing of a handfull of feathers across wind.

LOW PRESSURE SYSTEMS

Low-pressure liquid carbon dioxide fire extinguishing systems are designed to take advantage of the unique properties discussed above. Large quantities of liquid carbon dioxide are stored in single pressure vessels. This makes it possible to economically store large amounts of this extinguishing medium with a minimum of steel requirements and floor space. Very often a single low-pressure liquid carbon dioxide storage tank is used to protect many hazards. In the majority of cases, the capacity storage tank chosen is such that there is a sufficient quantity of liquid carbon dioxide available to give double shot protection to the largest hazard requirement. For example, if the largest hazard being protected by this storage tank should happen to require 5 tons of carbon dioxide, at least a 10 ton capacity storage tank would be installed. Thus, if a fire develops

in this large hazard after the required amount of carbon dioxide has been discharged, there is enough gas remaining in the tank to immediately re-protect this hazard.

Both manually and automatically operated systems are available. All automatic systems, of course, can be operated manually. An automatic system has appropriate fire detectors located in the hazard being protected. When fire occurs, the heat therefrom causes the fire detector to close an electric circuit which operates a relay on an electric control panel. Immediately, an alarm sounds in the hazard and an electric timer starts to operate. At the same time, it is possible to have automatic window and door closers and to shut down exhaust fans or other operating equipment. If personnel may be present in the hazard, it is desirable to allow a given length of time for them to leave the space. If this is the case, after the fire detector operates, a certain length of time is allowed to elapse before the timer causes the control valves to open. When the valves open, liquid carbon dioxide rushes from the tank into, or onto, the area in which fire has been detected. These valves are maintained in the open position for the required length of time to extinguish the fire, at which time the timer automatically causes the valves to close, retaining the rest of the carbon dioxide in the storage tank.

When more than one hazard is being protected from a central storage tank, it is common practice to have an automatic master control valve located near the tank with a pipe header running down along the various hazards. A branch pipe line leads from the common pipe header to each of the hazards. A selector valve, also automatically operated, is mounted in each of these branch lines; thus, when fire is detected and gas is discharged, the master control valve and the appropriate selector valve open, directing the carbon dioxide into the particular hazard in trouble.

These automatic systems almost invariably are so designed that if a person detects a fire in any one of the hazards before the automatic fire detectors operate, he can start the operation of the system by pulling a lever at an appropriate pushbutton station and pushing a button located behind the glass. These automatic systems can also be operated manually by breaking a glass at appropriate manual pilot valve stations and operating the manual pilot valves located therein. In other words, it is possible to operate the solenoid valves independent of the electrical circuits.

The manual systems are much like the automatic systems except for the automatic detection and automatic time discharge. In the case of the manual systems, when fire is detected by the personnel present, the appropriate manual pilot valves are open for the desired length of time and then manually closed.

It should perhaps be pointed out that with these systems it is possible to extinguish fire in two or three different hazards at the same time from the common storage tank. It should be pointed out also that the fire protection system is at no time disturbed when the supply of carbon dioxide is replenished. These systems are used in connection with enclosed spaces as well as localized indoor and outdoor fire hazards. In connection with local, direct application fire extinguishment, special nozzles are used to build up, locally, fire extinguishing concentrations of carbon dioxide. Special linear nozzles are used in connection with the protection of quench tanks and spray booths. Hose reels with hand projection nozzles are also used in connection with fixed fire protection systems.

Figure 3 — A truck-mounted 3-ton low pressure liquid carbon dioxide unit forms a highly mobile part of fire protection.

Figure 2 — A portable low pressure liquid carbon dioxide unit of 750 lb capacity, complete with hose and reel.

Besides the fixed fire protection systems described above, portable fire extinguishing units are available. One such unit is of 750 lb capacity and mounted on wheels. This unit is equipped with a 50 foot length of 1 inch hose, playpipe and nozzle mounted on a hose reel as a part of the unit. A picture of this unit is given as Figure 2. Three and five-ton-capacity mobile units are also available. In this case, the storage tanks are mounted on heavy-duty truck chassis. A picture of such a unit is given as Figure 3.

STEEL PLANT INSTALLATIONS

A brief description of typical systems installed in steel plants at the present time is given below:

1. *Quench tank and quench tank pit protection* — A 2 ton capacity low-pressure storage tank is used in connection with the manual protection of a quench tank approximately 40 feet long and 15 feet wide. This hazard is protected by local, direct application by means of special linear nozzles attached to the side walls of the tank. The pit hazard is protected by means

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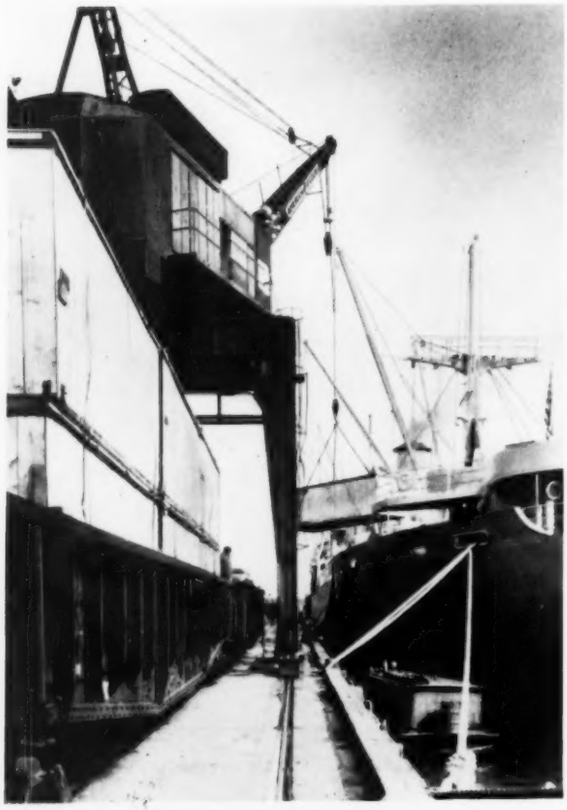

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of an automatic system attached to the same tank. This is a total flooding system. Hose reels are also attached to the same tank for general "mop up" work.

2. *Transformer vault protection* — This is a small automatic system having a one-half ton storage tank which gives only single shot protection. The fire is extinguished by totally flooding an enclosed space.

3. *Quench tank, pump room, oil storage basement protection* — A 2 ton storage tank is used to protect two quench tanks and an oil storage basement. The one quench tank is approximately 8 x 30 feet and is equipped with an automatic system which extinguishes fire by local, direct application. The second quench tank is approximately 10 x 40 feet. Fire in this unit is extinguished by means of local, direct application. The system is manually operated but does have automatic timing of the discharge. The oil storage basement has manual operation with automatic timing of the discharge. Fire is extinguished by total flooding of the enclosed space.

4. *6500 hp electric motor protection in 60 inch plate mill* — This very large motor is protected from a 4 ton storage tank. The system is operated manually with automatic timing. At the present time, local direct application is the fire extinguishing principle used.

5. *Electric and oil pipe tunnels* — This tunnel is protected with a 20 ton storage tank. The large, long tunnel has automatic fire detection and carbon dioxide discharge. The system is designed in such a manner that it is possible to totally flood the entire tunnel at one time. However, the tunnel is assumed to be four separate hazards, that is, if fire develops only in any one of the four sections of the tunnel, only that section will receive the carbon dioxide discharge.

6. *Electrical transformer, gas furnace and oil tank protection* — A 10 ton storage tank is used in protecting these miscellaneous hazards. Three transformers located in a bay 16 x 40 feet are protected by means of local, direct application. This part of the system is completely automatic. The same storage tank also protects two quench tanks by means of local, direct application. One tank is 15 feet in diameter while the other is 8 x 20 feet. Besides this, the 10 ton storage tank also protects a basement furnace area. At the same time, this tank protects a room 20 x 30 x 40 feet containing oil coolers, filters and accumulators. This is a total flooding system, completely automatic. An oil pump room communicating with the above room is also protected by an automatic branch of the system. If fire is detected in only one of the two rooms, gas will be discharged into that particular room. However, if fire develops in the other room simultaneously, then the other room will also be totally flooded. Besides the above described hazards, the same 20 ton storage tank also protects a small outside oil pump house by means of an automatic total flooding branch of the system. A number of hose reels are also attached to this tank to extinguish small incipient fires throughout these various hazards.

The above typical systems have been chosen from a much longer list of steel plant hazards being protected by low-pressure liquid carbon dioxide fire extinguishing systems. They have been chosen to illustrate something of the scope of the protection available by means of these systems.

Developments IN THE IRON AND STEEL INDUSTRY DURING *1943*

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. . . . This material was prepared by the A. I. S. E. Development Committee, of which Mr. Burr is chairman.

▲ A broad perspective of 1943 in the steel industry immediately brings out two important but anomalous points — the steel industry has produced enough steel, and the program to boost annual steel capacity by 10,000,000 tons has fallen far behind schedule. The optimistic 92,000,000 tons of ingots projected a year ago for the 1943 output has been satisfied by a production of 89,000,000 tons, approximately 500,000 tons less than it might have been had it not been for four coal strikes during the year. On the other hand, the 97,000,000 ton capacity goal set for July 1st was 6,000,000 tons away at that date, and still has not been attained.

The delay in completion is directly attributable to the priority ratings assigned to the steel program, which invariably remained several steps behind those assigned to high octane gasoline, synthetic rubber and aluminum. As steel was gradually promoted from A-2, through A-1-k, A-1-a, AA-3 and AA-2-x, it was ever preceded by these other programs with better priorities up to AA-1. Thus, there were months during which it was virtually impossible to obtain critical materials and equipment with which to carry on the expansion projects. Many projects bordering upon completion were stymied and held up for lack of some comparatively small but essential item of equipment. Construction schedules and completion dates were subject to revision after revision.

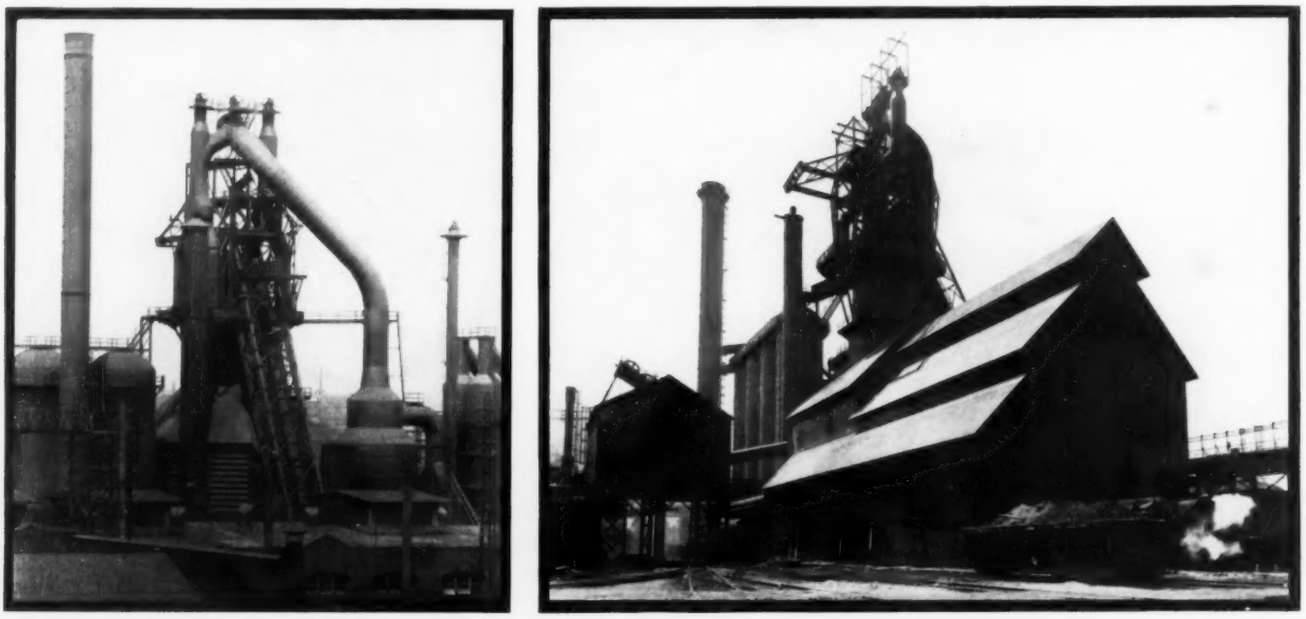
It will be recalled that the question of extensive expansion of steel capacity invoked much discussion before the program was started. Many felt that the existing production capacity was adequate to meet the demands of war production if civilian consumption was drastically curtailed, and that only certain units might be needed to properly balance production to the type of products required. On the other hand were those, principally in governmental agencies, who held that more of everything was needed, with little thought of balance or manpower limitations. As it happens, the former group seem to have been correct, but lest this hind-sight be taken as "I-told-you-so," let us hasten to say that it would have required a stout heart indeed in those dismal days two years ago to have held out against expansion.

And so, expansion we have, which up to date has consumed more steel than it has produced. Granting that high octane gasoline, synthetic rubber, and aluminum were sorely needed, it might seem that the hesitation in giving steel plant construction a clear track reflected some indecision as to its necessity. In the latter half of the past year progress has been better, and much of the program has been completed.

A noteworthy trend has been evident for the past two years in the free exchange of ideas and information, which has contributed greatly to the industry's production achievements. For the greater part, this has been individual and company work, although some good committee work has also been accomplished. A criticism might be leveled at some of the organized effort to increase the "know-how" pool, in that their work was laid out along long range lines, and therefore has produced few results to date. It is to be hoped that work on these long range problems will be carried on to a conclusion, however, and not allowed to lapse at the conclusion of the emergency.

The expansion in sintering capacity has been quite marked, with about 22 plants totaling over 10,000,000 tons annual capacity variously completed and under construction. This will bring the country's capacity to about 26,500,000 tons per year. This growth is a reflection of increasing acceptance by operators of the use of sinter. It is conservatively stated that one additional ton of iron will be produced for every 10 tons of sinter charged. The practice of sizing ore and coke and charging the different sizes separately has also been proven highly beneficial and is being extended to a considerable degree.

Blast conditioning continues to be a disputed topic.



New blast furnaces have added approximately 8,000,000 tons to our annual pig iron capacity. New furnaces are of large hearth diameter, with 28— ft the maximum at present.

BLAST FURNACES

In spite of the completion of many of the new blast furnaces included in the expansion program, iron production in 1943 exceeded that of 1942 by only some two million tons, totaling about 61 million tons, or about 6 million tons under the figure projected a year ago. A number of circumstances combined to hold down the year's output, including the four coal strikes, approximately 75 relining jobs (or about 50 per cent more than in 1942), and unavoidable delay in finishing expansion projects. Blowing equipment has been a bottleneck of no small consequence.

In spite of the handicaps, annual capacity has been increased about 8,000,000 tons in 1943, and now totals about 70,000,000 tons, the growth arising from the building of new furnaces and from the modernization and enlargement of other furnaces. The entire program includes 22 new furnaces, and completion is scheduled for mid-1944.

A new monthly production mark for a single furnace was set early in 1943 and has survived the attempts of other units to beat it. This record is 49,705 tons, or an average daily production of 1603 tons.

Fourteen conditioning units have been installed, being variously used on the suction or discharge of the blower and operating with chemical absorption or refrigeration. Reports range from no apparent gains, through a 5 per cent gain in production, to more optimistic figures. The majority of operators seem to believe that uniformity of moisture in the blast is of greater moment than a low moisture content. In one plant, tests, in which moisture was held constant at about the maximum natural atmospheric moisture content by the addition of steam to the blast, indicated a more uniform analysis of iron with respect to silicon. Unfortunately, the lining of the furnace upon which these tests were made was deteriorated to such an extent that figures on production and coke consumption were of little value.

Some interesting information should be forthcoming from exhaustive tests which are planned for one of the new DPC furnaces recently placed in operation. Under the guidance of a committee of furnace operators these tests will undertake to determine maximum blast which can be used on a furnace, the relation between flue dust and blast volume, between blast volume and a hanging stock column, and the effects of increasing the working

pressures of the furnace. The furnace is equipped with an automatically controlled choke valve so that the furnace may be operated under pressures considerably higher than usual, ranging up to 10 psi top pressure. It is planned to run the two turbo-blowers in series in order to supply the high volumes and pressures which will be required for this operation.

In all phases of blast furnace maintenance, records were made which contributed greatly to the total iron output. Ingenuity has led to many time-saving short cuts. Complete relining, normally estimated to require about 60 days, has been reduced to about half of this figure. One relining job established the record of 18 days, 20½ hours, not including time for drying out. Contributing to these records are a number of practices, including tapping of the salamander, precutting hearth blocks outside of the furnace, installing the lining simultaneously in two stages, the use of hot blast for drying out the new lining, etc. Naturally, large forces of men are required, working in round-the-clock schedules.

In spite of a delay of a month or more in the opening of navigation on the Great Lakes the ore season closed early in December with sufficient ore moved to insure blast furnace operation through the closed season. Attainment of this goal was aided in some degree by the retardation of completion of new blast furnaces and the consequent lowered consumption of ore.

Through the year, 21 ore mining projects have been undertaken, totaling an annual capacity of about 13,000,000 tons. These projects have not been completed, and added little to the past season's supply.

Likewise, coke supply has been built up by the construction of 16 by-product coke oven plants, and by the rehabilitation of some old units. By-product coke capacity now stands at about 57,000,000 tons of coke per year, an increase of 6,000,000 tons during the past year. Supplementing this is a production of coke of the order of 8,000,000 tons from beehive ovens, most of them located in Pennsylvania. This extra coke, essential to our high rate of blast furnace operation, has suffered somewhat by a deterioration in the quality of coal available to the beehive ovens, and has resulted in a higher coke rate and reduced iron production in the furnaces operating on beehive coke.

STEELMAKING

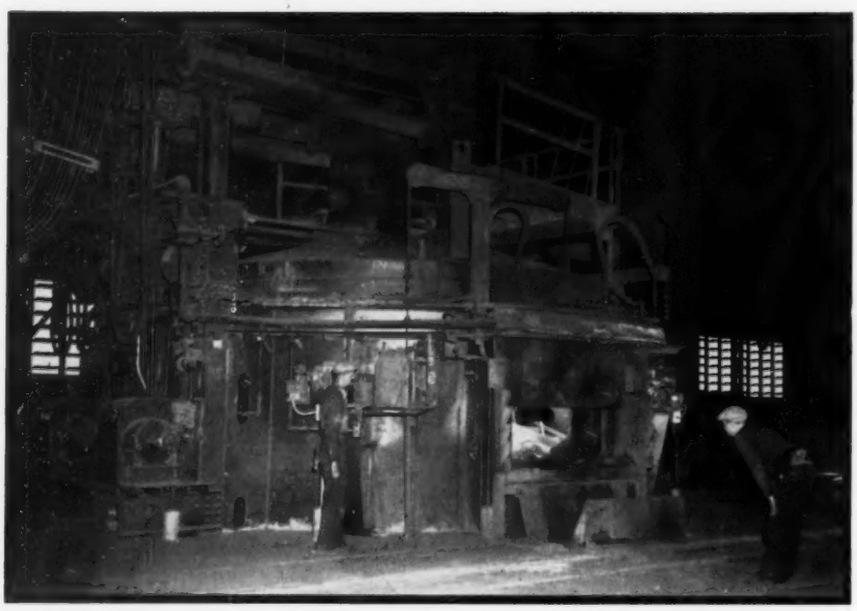
Open hearth production for the year past is about 78,500,000 tons, approximately 2,300,000 tons above 1942. The increase arises from additional new furnace capacity, from keeping furnace outage to a minimum, and from an increased operating rate in existing furnaces. In October, a monthly production record was established with a total production of 7,819,061 tons of ingots from open hearth, electric and bessemer.

The expansion program calls for increased open hearth capacity to the extent of about 7¼ million tons per year, much of which is now completed. Of this, 5½ million lies in new furnaces included in 12 major projects, ¾ million in enlargement of existing furnaces and 1 million in the use of hot metal charges. In some existing furnaces, larger heats have been tapped by lengthening or widening the hearth or increasing the depth of bath. Current open hearth capacity is about 84,200,000 tons of ingots per year.

By proper planning of rebuilds, and the use of better refractories, it has been possible to operate furnaces 90-95 per cent of the time instead of the nominal 87½ per cent. Basic brick has in some cases been used for the entire construction above the floor level with the exception of the roof, front wall arches and wing panels.

The use of high magnesia ramming mixtures for basic open hearth and electric furnace bottoms has increased greatly, contributing considerably to increased steel production by cutting the time required for putting in a bottom to 25 per cent or less of that required for burning in a bottom. Since no slag, and but a minimum of binder, is added to the mixture during installation, such bottoms will contain about 80 per cent magnesia.

Open hearth capacity has been materially increased by the completion of several new plants. High rates of production were maintained through the year by ingenious methods of operation and maintenance.



Expansion of electric furnace installations has brought the nominal annual capacity to about 6,000,000 tons. Hot metal facilities in some plants raise the total even beyond this figure.

Properly installed, the bottom will show a cold crushing strength of about 1500 psi, a modulus of rupture of 350 psi and a density of 165-170 lb per cu ft. At this density the material contains about 130 lb of periclase per cu ft, a higher concentration of this desirable constituent than obtained in other methods of bottom construction. This material is also widely used in the repair of tap holes, furnace banks, etc.

In general, roof life has decreased because of the hard driving to which the furnaces have been subjected. One plant reports on the use of a suspended roof construction, however, which is said to be approaching a life of 300 heats.

Rates of production have in general increased, due to a combination of faster charging, harder driving, keeping checkers clean by regular blowing, sealing the furnace, forced draft, slag control, rapid methods of analysis, etc. In some shops, production rates have been stepped up to 20-25 tons per furnace hour, and with duplexing, considerably higher.

In many cases, hot metal charges have been increased as new blast furnaces came into production. Overall, this has been a mixed blessing. Where the hot metal charge has been low, a gain in open hearth production was experienced. Beyond a certain point, however, open hearth production dropped somewhat. Some operators report the optimum to lie between 60 and 65 per cent.

The electric arc furnace construction program has proceeded through the year, with some apparent slackening of pressure to bring about completion. The capacity at the end of the year is approximately 6,000,000 tons of ingots per year, as compared to 4,500,000 tons at the start of the year. Production in 1943 totaled approximately 4,600,000 tons. A WPB directive in November set up certain classes of material that must be produced in electric furnaces. These steels, which include aircraft quality, bearing and gear steels, certain gun steels, etc., had in part been shifted to the open hearth furnaces. Increased arc furnace capacity makes their return possible, and at the same time frees the open hearths for carbon steel production. As soon as open hearth capacity opens up, however, much of this steel will be transferred back to that process. It has already been stated by WPB that there will be an excess electric furnace capacity of 200,000 tons per month (about 40 per cent of the total) during the first quarter of 1944.

During the past year some of the facilities for providing hot metal charges for arc furnaces have been completed. One plant is operating a solid bottom cupola, and charging the high carbon metal into the electrics. Another is using four solid bottom cupolas 130 in. in diameter in conjunction with 12 ton acid convertors to supply a medium carbon steel to electric furnaces. The cupolas are specially designed to operate continuously over a relatively long period of time. Turnings, borings and other light grades of scrap, either unconditioned or briquetted, are used as a cupola charge. This equipment has not been operating long enough to give a complete picture of the overall combination. However, the triplex operation of cupolas, convertors and electric furnaces is successfully carried out in the production of steel for castings.

Nearing completion also is the new completely integrated electric steel plant in the Chicago area, where the meltdown product from 200 ton tilting open hearths will be charged into large electric furnaces. This project is held up somewhat by secondary rolling and finishing facilities.

More and more, operators are being won over to the rotating type of arc control, which is now available from three large electrical equipment manufacturers. This type of control is said to give smooth, speedy operation, with close regulation of the arc.

In switchgear for arc furnaces there is a trend toward relieving the main circuit breaker of the frequent opening and closing duty required in the operation of the furnace. One plant has installed air breakers in the furnace transformer rooms for the operating duty, backed up by oil breakers in the main substation for interrupting capacity.

Sponge iron, subject of much acid debate in the past two years, is still more or less in the same status. Little has been heard in the past months of the experimental programs. One plant (mentioned last year) is under

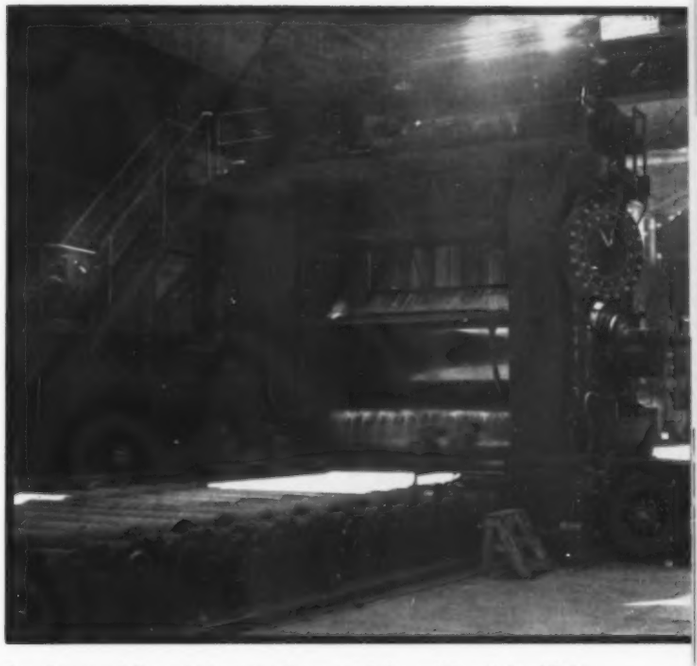
construction, in which fine ore concentrates will be dried and charged into a 12 hearth Herreshoff roasting furnace 20 ft in diameter. As the ore drops downward from hearth to hearth, heated coke oven gas will rise upward through the various hearths. At the proper temperature, this gas will react with the oxygen in the ore, producing finely divided particles of metallic iron. These particles, hot and relatively soft, will then pass through a set of rolls which will compress the material into hard compact briquettes.

A report from the Bureau of Mines on their sponge iron project indicates the development of a method of producing sponge iron of low sulphur content in standard internally fired rotary kilns from iron ore and solid reducing agents. Powdered limestone was mixed with a low temperature coke in proportions of about one to five. The coke was ground to pass a 4-mesh screen. Using New York magnetite with this lime-coke magnetite, a sponge iron ranging .04-.07 per cent sulphur was obtained.

A comparative newcomer to steel plant equipment is the briquetting machine, a unit formerly left to the material supplier. Shortages and the necessity of "scraping the bottom of the barrel" in many items, however, have resulted in the installation of these machines in many plants, used for briquetting turnings, charge and feed ore for steel making furnaces, blast furnace flue dust, etc. In preparing turnings, it is first desirable to extract the accompanying cutting oil, then crush the turnings, and finally feed them into the briquetting machine. Suitable conveyors, hoppers and feeders handle the turnings and briquettes through the process, with a minimum labor requirement.

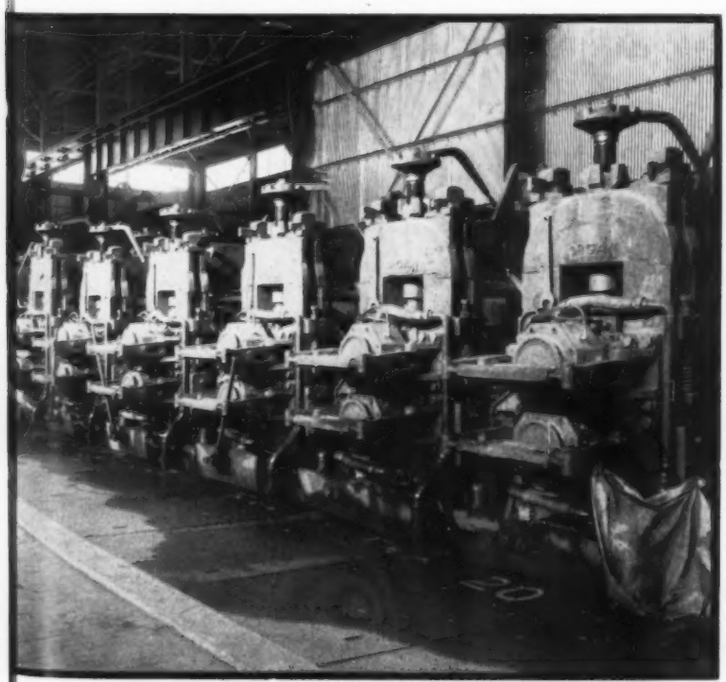
A machine in use in one plant for briquetting ore has a batch mixer operating in a hopper which receives a measured amount of ore from an overhead bin. The desired moisture and a binder are mixed in, and the aggregate then moved into a storage hopper from which it is fed into the compression chambers. Pressure to the extent of 2000 psi is applied by pistons. The briquettes weigh about 180 lb per cu ft against 90 lb per cu ft for loose ore. Screening, binder, mixing, and pressure all contribute to the formation of a satisfactory briquette.

A continuous machine has been installed by one company for briquetting blast furnace flue dust in a plant having no sintering facilities.



The demand for plates continues high, with all facilities operating at top speed. New plate mills are just beginning to aid the overall production.

Typical of the expansion of steel production facilities in the West is this modern continuous rod mill at the Pittsburg, California, plant of Columbia Steel Company.



ROLLING MILLS

Plate production continued to receive the principal attention in the rolling mill field, and through the conversion of existing mills, the rolling capacity has managed to keep up pretty well with the requirements. Throughout the year, universal plate mills have rolled 115,000-138,000 tons per month, sheared plate mills 440,000-465,000 tons per month, and wide strip mills 500,000-565,000 tons per month. Total plate production for the year is estimated at about 13,250,000 tons, and could have been greater had not the allocations of some of the strip mills been cut during several months. At the end of the year, however, the plate situation tightened even more, with the plants being asked to set new plate production records for the next several months.

Little help came to the plate situation during 1943 from the new plate mill installations accompanying the steel expansion program, although these units are variously nearing completion or have been recently put into operation. In addition to the mills mentioned in last year's article, this group includes a two-stand 110 in. mill in California and a single stand 110 in. mill in

Texas. The former consists of a two-high 44 in. x 112 in. reversing rougher, driven by two 3500 hp motors in a twin drive, and a 26½ in. and 40 in. x 110 in. three-high finisher driven by a 7000 hp. The Texas mill is a three-high 110 in. unit moved from Youngstown, Ohio.

In an eastern Pennsylvania plant an 84 in. three-high two-stand tandem plate mill is being rehabilitated by the installation of two new 2500 hp, 6600 volt, 251 rpm, 60 cycle induction motors to replace old 1600 hp, 25 cycle motors. The new motors will be totally enclosed and force ventilated with filtered air. The increased motor capacity will permit greater production. Another mill in the St. Louis area is also undergoing modernization.

A reversing universal plate mill is under construction in Mexico. Initially the mill will produce sheared and universal plate directly from ingots. Provisions are made for the future installation of hot coilers to allow the production of hot strip. This mill will be driven by a 2250 hp, 50-100 rpm, 700 volt d-c reversing motor.

The reversing roughing stand of the 132 in. plate mill mentioned last year and just completed in Utah is equipped with an automatic preset screwdown control. The settings of the screws for each pass of a particular rolling schedule are pre-selected on one of two plug selector panels arranged beside the roller's master control benchboard, and during the rolling of each plate the screwdown is automatically moved to the next succeeding pass position merely by advancing the pass selector master switch from point to point. Two independent plug selector panels are provided, and either one may be selected for automatic control by means of a schedule selector switch. Thus while the mill is operating on the schedule set up on the one panel, a new schedule for the next order may be set up on the second panel, and the screwdown control can immediately be transferred to the schedule required for the next order without any delay to select the pass positions for the new schedule.

The screws are driven by two 100 hp, 485 rpm shunt wound, mill type motors, supplied with power from two 100 kw variable voltage generators. Variable voltage control enables high speed operation during long screw movements, as well as accurately controlled slowdown and inching to assure accurate stopping at the selected pass positions. A method of slowdown control responsive to the motor speed and distance from the stopping point enables each movement to be made at the maximum possible speed and thus in minimum time, while retaining a high degree of accuracy in making all settings. Further improvements from similar earlier equipment enabled a great reduction in the number of interconnections between the plug selector panels and the limit switch, reduction in overall size of the plug selector panels and limit switch, and the simplification of setting up schedules on the plug selector boards. One operator is enabled to completely control the reversing roughing mill, including approach, main, and delivery tables, screwdown, horizontal and edger roll main drives, edger roll adjustment, and entry and delivery sideguards.

One new mill has a dual cooling and lubricating system developed especially for the requirements of composition roll neck bearings. The slow-operating rolls in the mill are lubricated with grease and cooled with water played directly on the necks. The high-speed rolls are lubricated and cooled with water while operating, but grease is applied just before the mill is stopped. Thus, starting is easy regardless of how long the mill stands, and the roll necks are protected against roughening corrosion.

Contributing to the longer life of composition bearings are improved filtering systems for the water used to cool and lubricate the bearings. Reports show a doubling of the bearing life in many cases.

Activity in rolling mills for aluminum has been particularly pronounced during the past year, with the completion of mills in Washington, Illinois, Ohio and New York. These mills include a reversing blooming mill, bar breakdown and finishing mills, rod and merchant mills, reversing hot mills, tandem hot strip mills, tandem and single stand cold mills, and skin pass mills. These mills to a great extent follow the design of steel plant equipment, differing of course in accordance with requirements of the process.

For carrying electric power to the individual roller drives of long mill tables, a new type of bus duct has been developed, made of heavy gauge sheet metal formed into rectangles about 10 in. x 12 in. x 20 ft. Main power circuits are carried along the bottom of the duct interior on glazed porcelain insulators, and supple-

The development of a process of piercing rounds to form the bore of gun tubes opened up a severe bottle-neck in the production of guns.

mentary control circuits are mounted on the rear wall of the duct. Individual sets of contactors are provided for each motor, spaced inside the duct at intervals corresponding to the distance between motors. Each 20 ft section of duct contains 8 to 10 stations to serve an equal number of motors. A plug-in type connection is mounted on the front of the duct for each motor. Ducts of this type have been applied to several new mills, taking the place of the usual arrangement of outlet boxes mounted between motors and tied together with conduit, and saving much installation time.

In several instances it has fallen to the lot of the steel mills to carry further the forming or fabrication of rolled products, with considerable saving in material and in labor. Two cases at hand are based on the use of pierced steel rounds, one as a step in the production of gun barrels and the second in the production of hollow railway axles. In the former case, round billets are pierced and rolled, the end heated inductively and upset to form the breech, and finally heat treated and quenched in a continuous conveyor line. The tubes are then shipped to government arsenals for finishing. One continuous heat treating line can produce 6000 75 mm gun tubes per month. More than 5 hr of forging and boring time are saved on each tube.

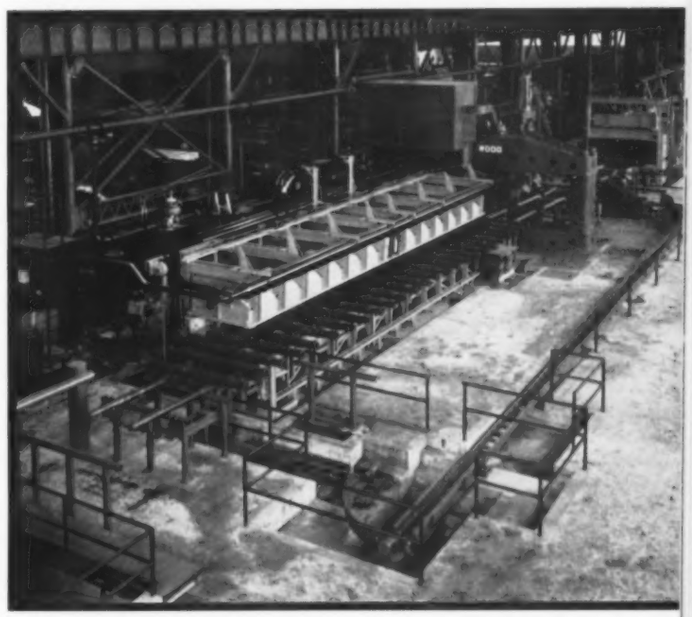
The production of hollow railway axles was begun recently on a continuous line (Iron and Steel Engineer, November, 1943). In this unit, each end of a pierced round of the proper length is heated, upset and forged, the tube then heated, quenched, and tempered, and both ends finally machined for centering, all in the continuous production line. Approximately 250 axles may be turned out in an 8 hr turn, with a saving in weight of 25-42 per cent, and a considerable reduction in machining time.

A significant step in our Association was taken last year with the formation of a separate Rolling Mill Committee, to cover the field of mills and roll design. Previously, this work was covered by other committees of the Association. It was felt that better work could be done, with greater service to the industry, by the formation of a separate committee. The first meeting sponsored by this committee was held last spring, and the results were most gratifying, both from the standpoint of interest shown and from the material which was presented in papers.

FURNACES AND CONTROL

A natural result of the feverish tempo of armament and ordnance production is the development of heating furnaces and auxiliary equipment to accommodate the various heating and treating operations required by war material. A considerable number of rotary hearth furnaces, in sizes ranging up to 10-12 tons per hour, have been applied in heating billets for forging, pressing and upsetting. These designs have been improved, using a solid pancake hearth which rotates beneath the walls rather than between them, as well as a flat suspended roof, thus eliminating many operating and mechanical problems.

Continuous production line methods have been applied to the heat treatment of armor plate up to ¾ in. thick in a continuous unit composed of hardening furnace, quenching unit and tempering furnace, through which the plate passes without handling. The quenching unit incorporated in these lines consists of a pair of gripping platens, the bottom platen being movable, the upper platen stationary. When the plate comes into position, the hydraulically operated bottom platen raises the plate off the roller conveyor and presses it against the upper platen. The hot plate is flooded with water from the hollow shoes forming the platen faces. Thin plates quenched in these units show a remarkable degree of straightness, some cases showing reductions of 65-80 per cent in the amount of straightening required.



This continuous production line forms pierced rounds into hollow railway axles and heat treats and centers them for machining of the journals.

New handling equipment has been designed whereby the heat treatment of alloy bar stock can be handled entirely by two men, from the loading table which is loaded by crane, through furnaces, quench tank, draw furnace, etc., to the discharge cradle, all in one continuous operation. Quenching time is automatically controlled.

Another example is a group of rotary furnaces for handling small objects through as many as three heat treatments and quenches, without any manual handling. The pieces undergoing treatment are handled by manipulators handled from a walking control station.

A development of considerable interest is the application of forced convection heating to a wide range of heat treating applications up to 1750 F. This expansion of its useful temperature range enables the convection heating furnace to perform hardening, spheroidizing, nitriding, and tempering operations, as well as the heat treatment of non-ferrous metals, such as aluminum and magnesium. Furnaces of this type offer great uniformity of temperature with close control, and may be designed in either batch or continuous types.

Controlled atmosphere furnaces have also come into wider use, particularly for bright annealing steels and alloys of steel in all carbon ranges. Bullet clips, bullet cores, rifle parts, etc., are treated in controlled atmospheres, eliminating scaling and decarburization.

An atmosphere used in many installations is one analyzing 94 per cent nitrogen, 3 per cent carbon monoxide and 3 per cent hydrogen. The carbon monoxide content is necessary to establish equilibrium, but if it is too high or too low, decarburization may result. This gas is made by burning a gaseous fuel in a combustion chamber and entirely removing the carbon dioxide by chemical absorption. As little as .2 per cent of carbon dioxide remaining in the gas is said to be detrimental.

The refractory industry has met the demands of wartime production in the steel and other refractory-consuming industries. The stoppage in imports of magnesite has been largely offset by domestic production of dead-burned magnesite grains in the state of Washington and by a project in New Jersey making high quality magnesite from sea water and dolomite. Fireclay refractory production has been expanded to a marked degree, and at the same time, the production has been widened geographically, with plants in all sections of the country. Plant equipment has been modernized with vacuum power presses and de-aired extrusion methods of manufacture, grain sizing and uniform mixing of materials, high firing temperatures, controlled kiln atmosphere, continuous tunnel kilns, etc., all contributing to improved refractory production.

In one case, the design of flat, suspended furnace roof has been improved, using relatively small refractory tile with intermeshing surfaces on all four sides, and arranged so that four blocks are supported by a refractory hanger which in turn is suspended from cast iron clips riding on overhead beams. The design offers a tight construction against air infiltration or gas leakage, and permits the insulation of 80 per cent of the refractory surface.

As a means of conserving the country's petroleum resources and guarding our national resources, the wider use of colloidal fuels has been given attention. One method of preparation uses a colloidal fuel mill which finishes the fine grinding of pulverized coal and mixes it intimately with fuel oil. Trials have indicated that the colloidal fuel is suitable for use in existing fuel oil installations without alteration. It is stated that the mixture is stable and will not separate, and that improved results in heating processes are often obtained with the mixed fuel. Proportions of 40 per cent coal and 60 per cent oil, as recommended, would mean a 47 per cent reduction in fuel oil consumption, and a consequent lengthening of the span of petroleum reserves.

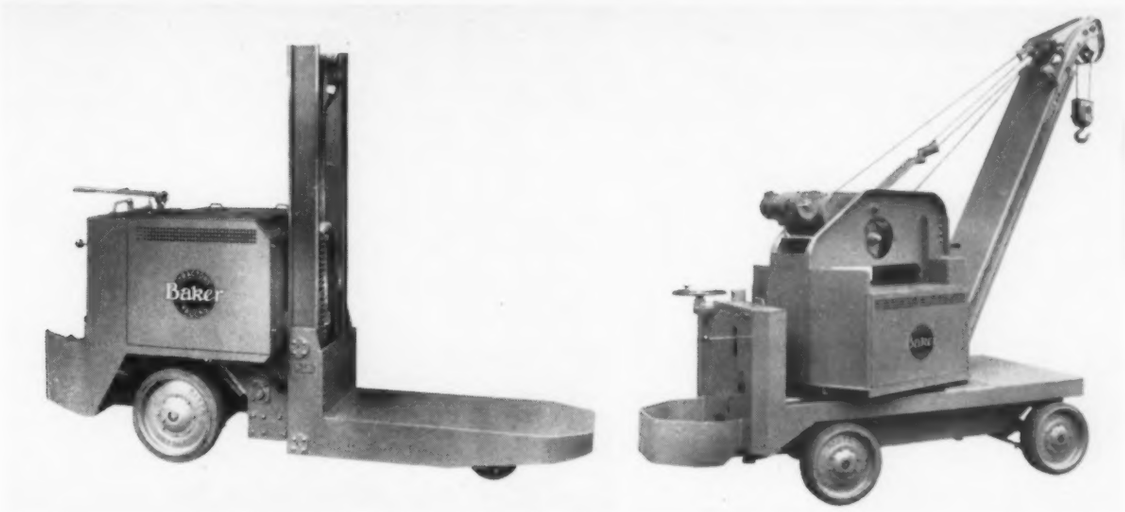
A development with considerable possibilities in the furnace control field is a line of regulators of simple, rugged construction, and relatively low priced. These regulators use low pressure air for their operation, from the same source as that supplying the air for combustion in the furnace. The two relative pressures which are to be proportioned or regulated are connected to opposite sides of the diaphragm of a pilot unit. The pilot diaphragm is mounted so that its movement changes the bleed flow of the low pressure air, diverting some of it to one side or the other of a power diaphragm which operates a valve or damper to restore conditions to the desired balance. These regulators are available in several models. For small units, the pilot unit may be omitted. The low cost of these regulators opens up a considerable field of applications which might be thought too small to justify more expensive equipment.

Another development in metering equipment is a pneumatic transmitter, which converts a measured impulse, such as a flow differential or a pressure, into an air pressure which varies proportionately with the measured impulse. The force produced by the measured impulse on a measuring diaphragm is balanced by a reaction diaphragm which operates an air bleed nozzle. The resultant pressure may be connected through tubing to a recorder or indicator which is calibrated to read directly in the terms measured, or the tube connection may lead to a meter body which transmits electrically to remote indicating, recording or integrating instruments.

A new style controller, used to control furnace pressure, fuel-air ratio, gas pressure, etc., uses a diaphragm measuring element which magnetically operates fully enclosed mercury switches. The mercury switches set up an electrical impulse when any deviation in the controlled valve occurs, the impulse being transmitted to the electrical power unit and multiplied through fully enclosed reversing relays into power sufficient to operate a valve or damper to restore conditions to the desired control point. The controller is provided with a stabilizer by means of which an air impulse created by the movement of the power unit is imposed on the controller to permit high speed of response without excessive over-travel.

In the majority of new furnace installations, complete automatic control is now considered a necessity. This control board is part of a new tilting open hearth installation.

A bellows-operated recorder for fuel oil flow and level which in many cases eliminates the need for separating chambers is now available, with a mechanism consisting simply of a metal bellows which seals the high pressure chamber from the low pressure chamber. No mercury is required. Construction is such that the mechanism may be heated if viscous oils are to be measured without separating chambers. The flow mechanism may be



Industrial truck manufacturers, while operating under certain production limitations, have proceeded with some improvements leading to more efficient operation.

connected to a recorder and integrator either mechanically or through an electrical transmission system for more remote installation.

A furnace temperature control system recently announced for electrically heated furnaces uses a suitable thermo-couple type of temperature controller with automatic electronic control of the saturation current of a saturable reactor connected in the supply line of the furnace heating elements, thus automatically controlling the power input into the furnace. The system may be used for temperature regulation of a single-phase or three-phase furnace. Where the line or furnace transformer voltage is not suitable to supply a-c to the thyratron tubes, an anode transformer is furnished. A droop corrector may be included in installations where the rate of material flowing through the furnace varies, thus compensating for heat exchange arising from fluctuations in the rate of furnace loading. Also included is a compensator which practically eliminates the affect of fluctuating line voltage upon the operation of the furnace.

ELECTROLYTIC TINNING

The electrolytic tinning program was practically completed during the past year, with 29 lines located in 13 plants. Twelve of these lines use the alkaline plating bath, and 17 use the acid process. Reflowing the coating is practiced on all of these lines, one using a hot oil bath, five using gas-fired furnaces, eleven using resistance heating, ten using inductive heating, and two using a combination of radiant and inductive heating. Most of the lines include a machine for chemically treating the plate either during or immediately following the quenching operation, usually using a ½-1 per cent solution of chromic acid which produces an extremely thin, uniform oxide film for surface protection.

The total capacity of these units, operating at their rated speeds, amounts to 48,600,000 base boxes per year, considerably more than the amount of all plate that will be used for heat processed foods in 1944. The construction of electrolytic tinning lines has outstripped the application of their product.

All electrolytic tinplate commercially used in heat processed food cans in 1943 had a coating weight of about .5 lb of tin per base box. This coating is not as resistant as the old 1.25 lb hot-dipped coating, and heat-processed food cans of electrolytic plate are enameled. It is thought that in 1944 some electrolytic plate carrying reflowed coatings of .6-1.0 lb per base box will be used for some foods for which the lighter coating is not satisfactory, and it is believed that reflowed electrolytic coatings of not over 1.0 lb will equal the 1.25 lb hot-dipped coating. Some authorities, however, do not believe that the heavy coatings can be economically applied with the equipment built for .5 lb coatings.

Considerable experimentation is proceeding along the lines of combination coatings, such as an alloy of tin and nickel. Tests also indicate that an electrogalvanized-bonderized-laquered surface offers a good resistance in severely corrosive exposures.

A number of selnium rectifiers have been completed to supply the low voltage, high current requirements of electrolytic tinning lines. Each rectifier bank has its own saturable core reactor for voltage control, and its own motor-driven blower for air cooling. The construction of the rectifiers has been described in a recent article (Iron and Steel Engineer, October, 1943). Each selenium rectifier installation consists of six 7500 ampere units, one 5000 ampere unit, and one 3000 ampere unit.

Copper oxide rectifiers have also been developed for this work. These are usually composed of 2500 ampere units, grouped in tiers into combinations of perhaps 60,000 amperes.

MATERIAL HANDLING

The A. I. S. E. committee that developed the standard crane specifications mentioned last year has continued its work. At the request of the Technical Board of the Wrought Steel Wheel Industry, standard designs

for crane track wheels were developed (Iron and Steel Engineer, November, 1943). These standards cover straight treads in diameters of 12-36 in., and tapered treads in diameters of 24-36 in. Several tread widths are used, according to the weight of the crane rail. Three main classes of wheels have been set up: standard wheels which will be applied to all new installations, standard wheels which are required for replacements on existing cranes, and special wheels with different hub diameters and lengths required for existing cranes. It is estimated that the standard wheels should cover about 90 per cent of the requirements.

Increased attention has been given to the air conditioning of mill pulpits, crane cabs, etc., as a means of offsetting excessive heat or cold, dust and waste gas. Such conditioning units are now available in a single enclosure which houses filters, condenser and blower unit. It is complete with insulated air duct, wire and conduit, and is completely connected at the factory. The unit is designed for easy location on new or existing cranes, and takes a minimum of floor space. It may be fitted on cranes of 5 to 250 tons capacity. Such conditioning units have been applied in aluminum, copper and steel plants.

Industrial truck manufacturers, under limitations imposed by WPB and mentioned last year, have confined their production to a certain few standardized models, and thus, new developments in this field have been limited. Some models, however, have been redesigned from the standpoint of reduction in dead weight, interchangeability, larger battery boxes for greater capacity, etc. Standardization of designs, coupled with the application of new and better manufacturing methods, has resulted in a greatly increased truck production from the facilities already on hand.

In keeping with the use of larger batteries in trucks, the gas-electric power plants used in some cases have been redesigned to afford greater power in smaller space.

The use of industrial trucks in the open hearth department has expanded to a marked degree. Fork trucks are the usual type, installed primarily for handling ferro-alloys from storage bins to charging boxes in bottom dump hoppers or containers. Numerous other uses have been found for the equipment, however, such as handling pallets loaded with hot tops, brick, and similar items, unloading cars of certain material, etc., all resulting in a reduction in labor for handling materials.

Mechanical loaders, in a suitable range of sizes, are receiving wide use in the iron ore mines, particularly those which operate underground. Recently, this type of unit has been put into service in steel plants for cleaning out slag pockets when rebuilding open hearth furnaces. It is said that this practice saves one-half of the man-hours, and salvages a greater proportion of brick.

A new motor driven bucket has been developed for handling various loose, bulky materials. The bucket is self-contained, and is opened and closed by means of a double acting oil cylinder actuated by an oil pump driven by a 15 hp constant speed motor. The motor control is mounted in the crane cab, with a flexible cable leading to the bucket.

For handling armor plate up to 3 in. thick and 10,000 lb in weight, and checking its flatness, a table has been designed in which are incorporated spring mounted ball transfers with a capacity of 1000 lb per unit. The transfers may be raised and lowered hydraulically. The plate moves on to the table with the ball transfers in the up position. The transfers are then lowered and the plates allowed to rest on the level surface plate forming the top of the table, thus giving a check for straightness and flatness.

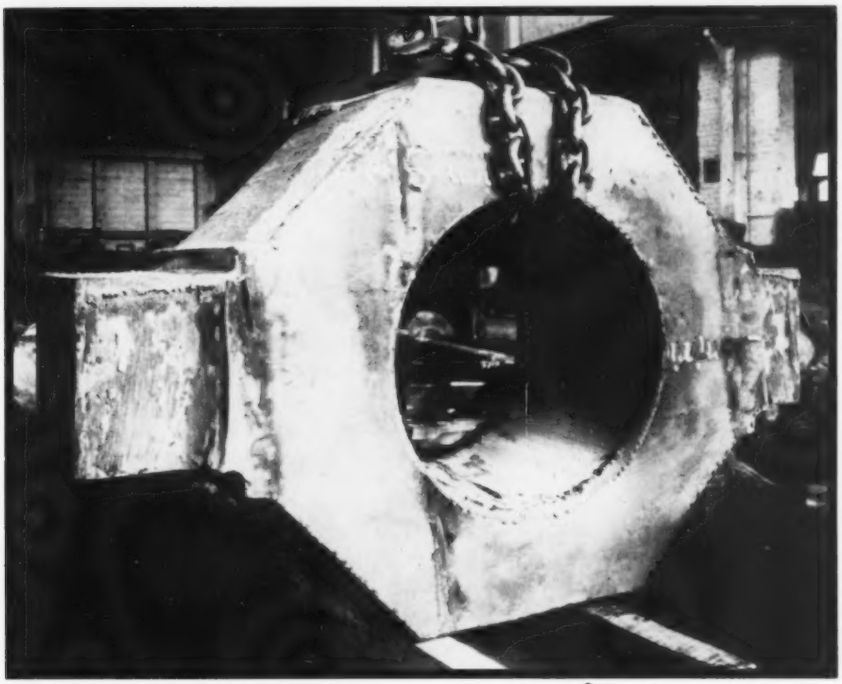
MECHANICAL DEVELOPMENTS

Given impetus by the necessities of production and the pinch in manpower, many ingenious adaptions have been made of oxy-acetylene cutting processes. A scarfing torch has been introduced capable of scarfing a shallow path of about 2½ in. wide, as compared to the usual 1-1½ in. scarf. It is estimated that the wider scarf gives a 30 per cent increase in the tonnage scarfed. The torch operates at slightly higher oxygen pressures, and is designed to permit a considerable increase in oxygen flow.

In many cases, flame cutting has been applied where shears might commonly be used, such as the cutting and cropping of billets. Slabs are slit into billets by multi-torch machines. Sections up to 4 or 5 ft thick are cut. Quite a number of steel foundries have installed oxy-acetylene cutting machines to replace hand torches for removing gates and risers, thus greatly reducing the amount of grinding required.

Aluminum bronzes, long known as bronzes highly resistant to wear and distortion, are being widely used in the form of welding electrodes for building up worn parts, such as slipper bearings, collector shoes, pistons, etc. These electrodes, available in five grades, can be used on most bronzes, various steels, malleable iron and clean cast iron with no difficulty once the operator learns the proper procedure. It can be welded on steel without preheating, thus making it particularly useful where preheating is impractical. In addition to many

Oxyacetylene cutting has materially speeded up the shaping of material to fit specific jobs. This illustration shows the simultaneous cutting of a stack of plates.



Cut with the oxyacetylene flame from a 7 ton slab, this 42 in. x 65 in. x 20 in. crosshead is an example of the work of gas-cutting machines.

maintenance applications, these electrodes have proven useful in repairing minor defects in bronze castings.

The use of metal spraying as an aid to maintenance has increased widely in the past year or two, and the list of applications covers the entire steel plant. High, medium and low carbon steels, various bronzes, stainless steel, aluminum, etc., have been used. Axles, shafts, journals, pistons, plungers, coiler reels, mill work rolls, pump casings, annealing pots — these, and many other parts have been so treated, with marked conservation of maintenance labor and material.

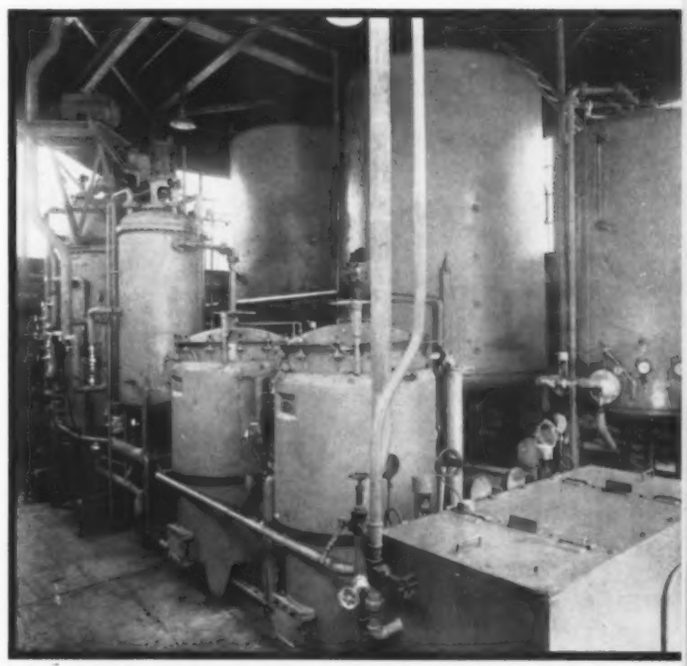
As a result of considerable trouble with submerged bearings in continuous tinplate processing lines, one company has developed a submerged, counter-pressure bearing, wherein needle type bearings take the radial load and a ball bearing the end thrust, all mounted in a self-aligning sleeve. The journal extends through two shaft packing closures, between which a compressed air pipe is connected, supplying air at a pressure in excess of the head of the liquid to be kept out of the bearing. The bearing is lubricated through a pipe at the outside end of the housing, which is tightly sealed at that end by a cap.

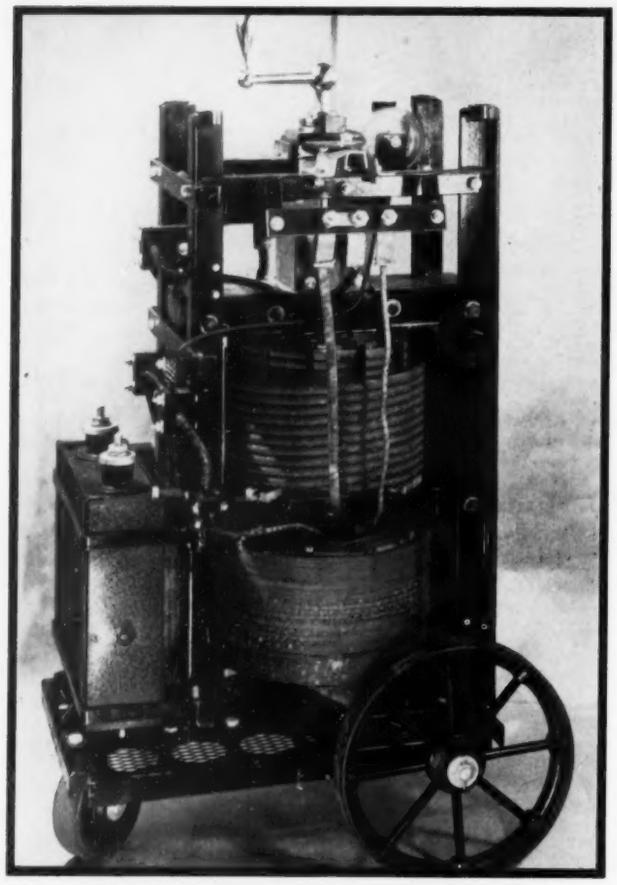
Synthetic rubber has stepped in to help strip picklers, scrubbers, cleaning and tinning lines, etc., over the rubber shortage, and reported results indicate good performance. Because synthetic rubber may be manufactured of special compounds which are particularly resistant to the action of chemicals, greases, steam or whatever the particular service requires, it may stand up much better than natural rubber.

The oil industry has been called on to fill many demands made by the steel industry. With curtailment of palm oil came the necessity of finding another cooling lubricant for the rolls of cold mills. Satisfactory replacements, manufactured from petroleum products and other ingredients on which no restriction exists, have been developed. Lubricating products, of standard and special characteristics, were found to successfully replace the animal suet used on many old mills and rendered scarce by the demand for glycerine.

Electric immersion heaters are used to automatically maintain constant temperature of lubricating oils in many lubricating systems on mills for rolling copper and brass. Maintenance of constant temperature is said to insure constant calibration of the mill. Heaters, under automatic temperature controllers, act to hold the oil in the storage tanks at 110 F. Smaller oil tanks are located at the base of the rolling mill stand, and are

As a means of palm oil conservation, systems such as shown here treat the used oil so that it may be reused on all types of cold mills without difficulty.





Interior view of a 1000 ampere a-c welder of the type widely used in fabricating work. View shows control panel, capacitor and transformer incorporated in the welder.

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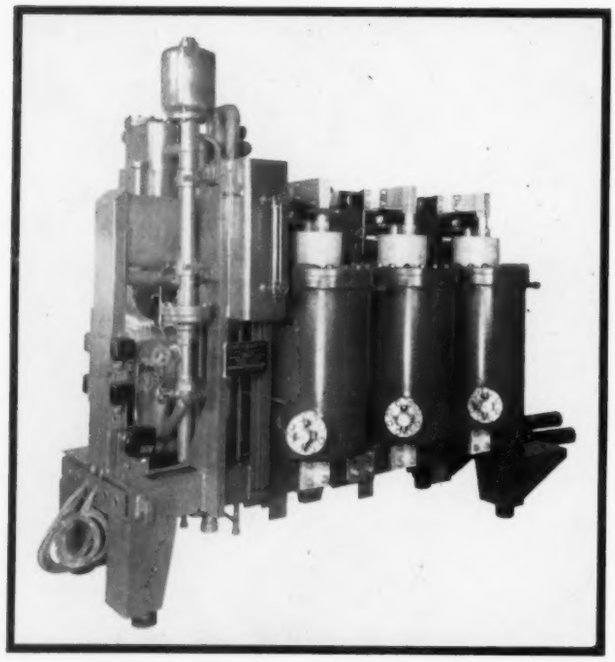
The use of mercury arc rectifiers has grown materially, particularly for 250 volt d-c power supply, but also for main drive power supply.



also equipped with automatically controlled immersion heaters. From these small tanks oil flows to the roll neck bearings, then through a filter and back to the main storage tank.

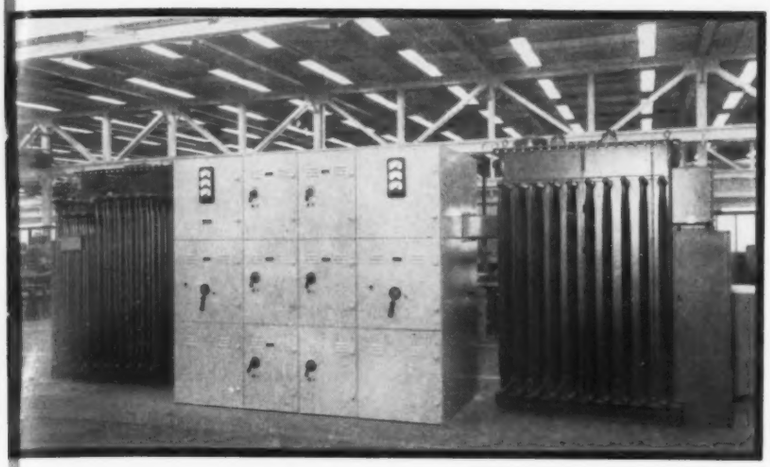
ELECTRICAL DEVELOPMENTS

There has been much published, particularly in the general press, which would lead one to believe that electronics is a new, mysterious subject which is, in the future, going to eliminate the necessity for work. Actually, electronics have been with us for quite a while and there is already a broad application in the steel industry. These uses include rectifiers, pyrometers, photoelectric relays, battery chargers, exciters, welders, pinhole detectors, etc. Some recent applications include very accurate speed control, as for flying shears, saw carriage drives, temper pass mills, loop control, etc.; accurate tension control in the drawing of fine wire; control of lateral movement of a winding reel so as to obtain a coil with even edges; preset automatic screw-down control; etc.

Numerous installations of rectifiers have been made in steel plants, particularly for 250 volt d-c power supply, but also for main drive power supply. An arrangement of substations for a new large integrated steel plant in the West uses three separate distribution systems fed by nine mercury arc rectifiers located in eight substations. The rectifiers range in capacity from 750 kw to 2000 kw, and total 12,750 kw, the largest installation of rectifiers for auxiliary power supply in any steel plant. The substations are arranged for unattended operation, under the control of a central dispatcher through a supervisory control system.

A 2500 kw, 600 volt rectifier is being used to supply 13 adjustable speed 600 volt motors driving the 17 stands of an 18-14 in. merchant mill. These motors range from 100 hp to 1425 hp and total 7825 hp. The rectifier voltage may be regulated from zero to full voltage, so that the entire group of motors may be started together by connecting them to the rectifier at zero voltage and then bringing them up to running speed by raising the rectifier voltage. The rectifier transformer will have primary taps corresponding to about 420, 480, 540 and 600 volts on the rectifier d-c output.

In another case, a plant having a supply of blast furnace gas that can be used only in the generation of 25 cycle power installed a 3000 kw, 600 volt, 12 phase, 25 cycle mercury arc rectifier to operate in conjunction with a 4000 kw, 60 cycle synchronous motor generator set on a narrow strip mill. The 3000 kw rectifier and 4000 kw motor generator set are normally connected to the 600 volt d-c bus, from which are fed the nine mill drive motors. The system is operated at constant bus voltage, and the motors are started by individual magnetic controllers. A voltage regulator is arranged to maintain constant bus voltage by means of grid and ignition control of the rectifier, and a current regulator is arranged to maintain constant current output from the rectifier by controlling the excitation of the two 2000 kw generators. With this arrangement the rectifier is made to operate continuously at some fixed power output, the value dependent upon the amount of



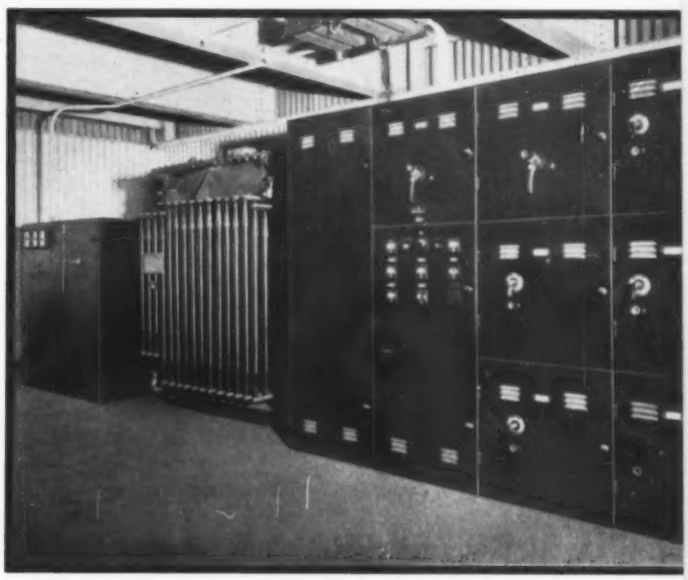
Typical 480 volt substation, complete with transformer and switchgear, for load center distribution.

25 cycle power available, and adjustable by means of the current adjusting rheostat. When the power required by the mill motors is greater than the rectifier output, the difference is supplied by the motor generator set, or when the motors are lightly loaded or shut down, the motor generator operates inverted to return power to the 60 cycle system.

Operating data is still lacking from two interesting rectifier applications which were mentioned in previous years, but which have been delayed by the pressure of war production. These installations are the 7000 kw unit to be used for supplying power to a hot strip mill, and the double rectifier unit to be used as a frequency changer for the interchange of power between a 25 cycle and a 60 cycle system. Both of these installations will be watched with interest by the industry.

To meet the demand for very fast, accurate control, beyond the performance of the usual electric regulating device, electronic regulators have been developed for maintaining and controlling the relation of current or voltage to a basic function or operation. Wearing parts are kept to a minimum, reducing maintenance to a minimum. The speed of response of the basic elements of the regulator is practically instantaneous, total speed being determined to some extent by the characteristics of the controlled unit. At present, this regulator is being used to control current in respect to speed, but it an be applied to control speed, temperature, light output, voltage, and similar functions.

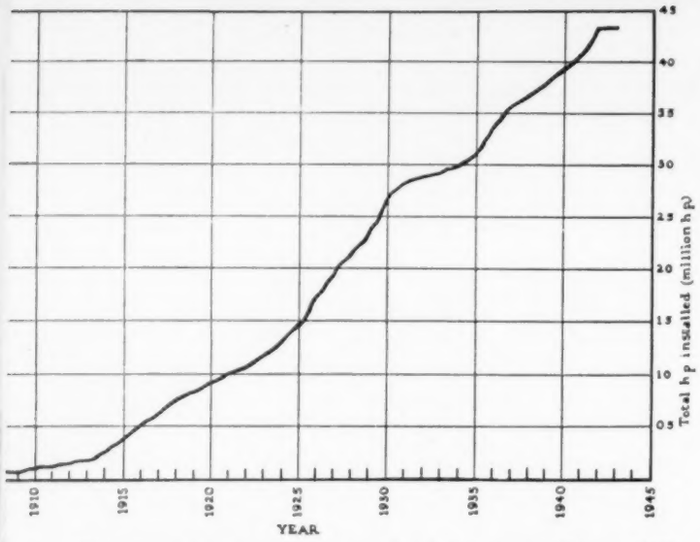
New plants have made widespread use of the principle of load center distribution for low voltage power, using relatively small unit substations placed close to the load. These assemblies usually consist of a step-down transformer with non-inflammable coolant, and a metal-enclosed air circuit breaker and switchboard for distribution feeders. A lighting transformer may also be added, as may a rectifier for supplying d-c feeders. These units save the copper required for long low voltage lines and eliminate voltage drop. They may be located indoors without enclosing them in fireproof vaults, and save installation labor and space. They may be easily expanded to meet increasing loads, and easily moved to meet changing load conditions.



Front view of a 300 kw, 250 volt sealed rectifier substation for d-c distribution.

Illustrating the apparatus and method for rapidly coating the contact surfaces of bus bars with silver.

Some use has been made of silver plating on the contact surfaces of copper bus bar to reduce the voltage drop at the joints. The plating may be done by a portable brush plating set, consisting of a small special rectifying power unit which can be plugged into any 110 volt a-c line, a plating brush having the appearance of a paint brush but containing a replaceable silver anode, and a silver-saturated electrolyte in the form of a thin paste. The copper surface is first cleaned by lightly sanding, followed by a commercial cleaning compound. The positive low voltage d-c lead is connected to the brush anode, and the negative lead to



The cumulative curve of main drive motors over 300 hp shows a total to January 1st, 1944, of 4,350,115 hp Twelve motors (20,800 hp) were added in 1943.

the bus bar. The energized brush applicator is saturated with the plating solution and brushed slowly over the surface to be plated. The process is simple and rapid, and has been also used on air circuit breaker contacts, where it shows a reduction of as much as two-thirds in the voltage drop as compared to uncoated contacts.

Several improved type of disconnect switches have been announced, of gang operated design, and fully enclosed. Their compact construction permits their being mounted anywhere and in any position. They are so designed that they can be opened safely under light loads and magnetizing currents.

Built for direct current work, in single pole form and a wide range of sizes, a circuit breaker has been designed which operates in an overall time of 1/120th of a second. This speed arises largely from the elimination of the usual latch and unlatching means. Contact opening is initiated by a magnetic release through a form of roller latch. Two accelerating springs move the relatively light contact mechanism through a short arc gap. The great speed of operation of this breaker opens the circuit so quickly that the peak to which a direct current short circuit current may rise is reduced to as little as 5 per cent of that encountered with many d-c breakers.

A definite increase is to be noted in the trend toward adjustable voltage auxiliary drives on blooming and slabbing mills, both on new units and as replacements for the older magnetic control. The use of auxiliary exciters in these variable voltage sets is also increasing.

To obtain the two speed operation common to the usual drawbench operation, a control system has been applied which supplies unbalanced primary voltages to a wound rotor motor. This control provides adjustable stable slow hook-on speed, continuous accelerating torque, ample torque for drawing, and a negative torque for slow-down on short draws. The hook-on speed can be adjusted over a rather wide range to suit conditions. Transformer taps provide 20, 28, 36, 45 and 54 per cent of rated speed under idling conditions, and adjustment of the secondary resistor will provide hook-on speeds between these values if desired. When the drawing hook drops in the chain, a limit switch is operated which causes acceleration of the drive motor by establishing balanced voltage conditions and commutating secondary resistor by normal accelerating means. This produces sufficient torque for any drawing condition without excessive current inrushes. When the return of the carriage is started, slow-down of the draw motor is initiated by providing an unbalanced voltage condition in the primary and inserting the secondary resistor. The stable slow speed for hook-on is reached in about 10 seconds, a rate of deceleration which has been found to be satisfactory on a large number of installations.

ELECTRIC MOTORS OVER THREE HUNDRED HORSEPOWER

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1943

Item	*Horse-power*	*Revolutions per minute*	*Volts*	*Frequency*	*Method of drive*	*Kind of mill*	*Purchaser*	*Location*	*Manufacturer*
1	300	600	4600	60*	Geared	Tube mill	Michigan Seamless Tube Company	Jackson, Michigan	Westinghouse
2	500	500/1000	600	d-c	Geared	Cold brass mill	Bridgeport Brass Company	Indianapolis, Indiana	Westinghouse
3	1000	720	2300	60*	Geared	Four-high cold mill	Chase Brass and Copper Company	Waterbury, Connecticut	Westinghouse
4	1000	605	2300	60*	Geared	Magnesium mill	Revere Copper and Brass Company	Baltimore, Maryland	Westinghouse
5	1250	600	2300	60†	Geared	26 in. x 36 in. 2-high cold mill	Chase Brass and Copper Company	Waterbury, Connecticut	General Electric
6	1500	500	6000	50†	Geared	450 mm merchant mill	U. S. Treasury, Procurement	Russia	Allis-Chalmers
7	2000	400/600	750	d-c	Geared	Rail mill	Siderurgica Belgo-Minera	South America	Westinghouse
8	2250	50/100	600	d-c	Direct	30 in. x 88 in. universal mill	Armco International	Mexico	Westinghouse
9	2500	250/500	750	d-c	Geared	Hot strip finishing mill	National Steel Company of Brazil	Volta Redonda, Brazil	General Electric
10	2500	257	6600	60†	Geared	Plate mill	Alan Wood Steel Company	Conshohocken, Pennsylvania	Westinghouse
11	2500	257	6600	60†	Geared	Plate mill	Alan Wood Steel Company	Conshohocken, Pennsylvania	Westinghouse
12	3500	50/120	700	d-c	Direct	35 in. blooming mill	Alan Wood Steel Company	Conshohocken, Pennsylvania	Westinghouse

*Synchronous
†—Induction

Company	*Location*	*Type of mill*	*Number of motors*	*Total horsepower*
Alan Wood Steel Company	Conshohocken, Pennsylvania	Plate mill	2	5000
		35 in. blooming mill	1	3500
Armco International	Mexico	30 in. x 88 in. universal mill	1	2250
Bridgeport Brass Company	Indianapolis, Indiana	Cold brass mill	1	500
Chase Brass and Copper Company	Waterbury, Connecticut	Four-high cold mill	1	1000
		Two-high cold mill	1	1250
Michigan Seamless Tube Company	Jackson, Michigan	Tube mill	1	300
National Steel Company of Brazil	Volta Redonda, Brazil	Hot strip finishing stand	1	2500
Revere Copper and Brass Company	Baltimore, Maryland	Magnesium mill	1	1000
Siderurgica Belgo-Minera	South America	Rail mill	1	2000
United States Treasury Procurement	Russia	Merchant mill	1	1500

Types of motors purchased	*Total motors*	*Total horsepower*
Alternating current motors	7	10,050
Direct current motors	5	10,750
Total	12	20,800

There's still a big job for all of us to do

NOTHING MATTERS NOW except the swift and certain winning of the war.

Through the prodigious production accomplishments of American industry, our men and our Allies have been able to swing the initiative in fighting to our side.

To keep it...to continue a steady march on the bloody road to victory... we've got to give our men in the thick of the fight everything they'll need. And give it to them faster and faster!

For you and for us there's *still* a big job to be done. The history of the amazing production performance of American industry is *still* to be written.

Every single man-hour, every bit of brain power, every ounce of industrial energy expended for any purpose other than victory will damage the war effort.

The entire production of Hyatt Roller Bearings now goes into planes our men fly... into tanks they drive... into ships they sail... into guns they man... into equipment they need to win.

In the midst of pouring out a tremendous stream of bearings for this vital war use, we pause to again thank industry for its grand cooperation and understanding, and for helping us meet war's demands for super-precision production on a mass scale.

As soon as the war's won, and this job is done, Industry and Hyatt will have another big job to do together... when we can work in Peace.

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

DIVISION OF

HYATT BEARINGS **GENERAL MOTORS**

IRON AND STEEL ENGINEER INDEX FOR 1943

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PRESIDENT

ASSOCIATION OF IRON AND STEEL ENGINEERS

The President's Message

You have seen fit to honor some of us by election to the highest offices of our Association and, on behalf of my fellow officers and myself, I extend our sincere thanks for this expression of confidence in our ability to carry on during one of the most critical periods in the history of our country. Our officers in the past have strived to faithfully fulfill this trust and we pledge ourselves to carry on these honored traditions.

Our Association has just completed a most successful year and we would remind you that this success has not come, and cannot come, from the efforts of the officers alone, but is due in a large part to the participation of yourselves.

The war is yet to be won and the victory to be paid for. Our Association can best play its part by a continued drive for new members who may benefit by our successes and mistakes of the past, by further contributions of technical papers for our district and national meetings, and by the insistence on the adoption of the various standards prepared by our Standardization Committees.

Chas. L. McGranahan

NEWLY ELECTED
A. I. S. E.
Officers and Directors
1944

J. L MILLER
FIRST VICE PRESIDENT

J. S. MURRAY
SECOND VICE PRESIDENT

J. LEDLIE MILLER has been employed in the steel industry since 1909, serving as messenger, draftsman, and in the experimental engineering department of Carnegie Steel until he joined the army, where he served overseas as a lieutenant in the heavy field artillery. Serving as fuel engineer at the Bellaire works of Carnegie from March 1919 until that fall, he returned to the Carnegie Institute of Technology where he received his degree in mechanical engineering the following year.

Mr. Miller returned to Bellaire as fuel engineer and when this plant was closed, went to the Follansbee Brothers plant in Toronto, where he was annealing department foreman and assistant metallurgist until January 1, 1925. He served as fuel engineer of the Wheeling Steel Corporation in the Wheeling district from 1925 until he went to Youngstown for Carnegie in 1928. He acted as assistant chief engineer of Carnegie-Illinois Steel Corporation in the Youngstown district from 1928 to 1936. In 1937 he was appointed assistant chief combustion engineer of Republic Steel Corporation with headquarters in Cleveland.

J. S. MURRAY was educated in the Toronto, Ohio, public schools Carnegie Institute of Technology, and the students course at Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. Mr. Murray entered the employ of Westinghouse in 1916, in the research and sales department. He entered consulting engineering work at Pittsburgh in 1918. In 1920 he went with the Follansbee Brothers Company as chief electrical engineer. He has supervised the production, test and application of silicon steel sheets produced by the Follansbee Steel Corporation since 1932.

J. D. JONES, chief engineer of the Youngstown Sheet and Tube Company, Youngstown, Ohio, was born and raised in Pittsburgh and was educated at Pittsburgh Academy. From the outset he was interested in steel and set out to obtain a wide range of experience in the production of steel. He has worked in steel plants in Wheeling, Chicago, Buffalo, Pittsburgh and other cities.

In 1912, Mr. Jones went to Sault Ste. Marie as chief engineer of the Algoma Steel Company. In 1916 he went to the Gary works of the Illinois Steel Company as chief engineer until the latter part of 1919, when he returned to Algoma Steel Company as general superintendent later becoming general manager and vice president. He went to Youngstown Sheet and Tube in August, 1935.

FREEMAN H. DYKE graduated from Phillip Andover Academy and from the Massachusetts Institute of Technology. Mr. Dyke started in the steel business with the Wheeling Steel Corporation at their Portsmouth plant in 1920, and with the exception of three years with the Jones and Laughlin Steel Corporation he has been with Wheeling Steel Corporation continuously. After serving in several capacities in various departments, Mr. Dyke became superintendent of the blooming, bar and hot strip mills at the Steubenville plant, and has recently been made assistant general manager in charge of steel works.

L. R. MILBURN was graduated from the University of Michigan with a degree of electrical engineering in June 1918. From July 1918 until 1919 he went with the General Electric Company doing testing, complaint, installation, and apparatus sales work. In March 1925, he moved to the Louisville Gas and Electric Company where he did construction work until October 1929, obtaining excellent knowledge of the working of the central station industry. Starting his steel mill career in October 1929 with the Great Lakes Steel Corporation as electrical draftsman, Mr. Milburn remained in this position until 1933 when he was appointed acting electrical engineer. In 1935 he was promoted to electrical engineer.

LOUIS F. COFFIN began work with the Bethlehem Steel Company as mechanical engineer in 1916. In 1920 he was made general master mechanic, and in 1932 was advanced to his present position of superintendent of the mechanical department at Sparrows Point, Maryland. Mr. Coffin was graduated from Swarthmore College in 1909 with a degree of bachelor of science in mechanical engineering.

WALTER H. BEYERLE was born in Bernville, Pennsylvania and attended Perkiomen Seminary and Pennsylvania State College, receiving a degree in electrical engineering in 1909. He then entered the apprentice course at Westinghouse Electric and Manufacturing Company and after a year of training, was employed by the Pennsylvania Steel Company, at Steelton, Pennsylvania. He was then transferred to a subsidiary company, the Spanish-American Iron Company, at Felton, Oriente, Cuba. In 1912 he was employed as test engineer by the Pennsylvania Water and Power Company, and three years later became associated with Bethlehem Steel Company, where he served in the electrical construction and power departments in Bethlehem until his transfer to the Sparrows Point plant as assistant electrical superintendent.

F. C. FRYE graduated from high school in Beaver, Pennsylvania, and started to work in the engineering department of the Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania in 1912. He was transferred to the steam and fuel department in 1914, and in 1919 went to Heppenstall Forge and Knife Company in charge of boilers and fuel. Mr. Frye next entered the employ of Crucible Steel Corporation, Midland, Pennsylvania, as boiler superintendent, and in 1922 went with United Alloy Steel Corporation, Canton, Ohio, in charge of boilers and fuel at their South Division. In 1925 he entered the boiler and welding business in Beaver Falls, Pennsylvania. Two years later he became associated with Crucible Steel Corporation, Pittsburgh, Pennsylvania, and then with Wheeling Steel Corporation, Steubenville, Ohio. He became steam engineer for Great Lakes Steel Corporation in 1930, and in 1932 took charge of the fuel and steam departments.

W. H. BEYERLE
DIRECTOR

A. J. FISHER
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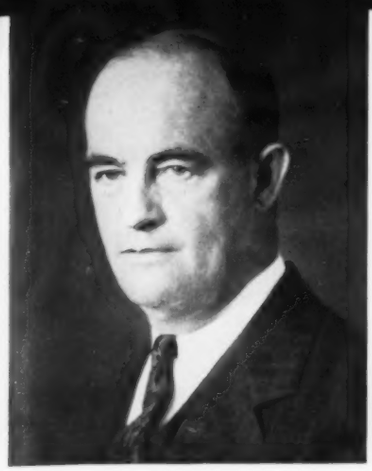

J. D. JONES
TREASURER

FREEMAN H. DYKE
SECRETARY

L. R. MILBURN
DIRECTOR AT LARGE

L. F. COFFIN
HONORARY DIRECTOR

F. B. NIELSEN was born in Norway and graduated in mechanical engineering from Bergen Technical Institute in 1914. After serving in the Norwegian Army, Mr. Nielsen entered the engineering department of the Stavanger Electro Steel Works in 1916. He became plant engineer, in 1918, in charge of new construction and maintenance. During this time he was awarded a scholarship for the study of foreign steel plants. In 1922, Mr. Nielsen came to the United States, where he entered the employ of Inland Steel Company. He was then employed by the American Steel and Wire Company at Waukegan works, and in 1924 became associated with the Tennessee Coal, Iron and Railroad Company at Birmingham, Alabama.

GEORGE H. ROSE, chief engineer of the American Steel and Wire Company, has been active in the engineering field for 40 years, 37 of which have been with American Steel and Wire. Following his graduation from Case School of Applied Science, in Cleveland, Mr. Rose served as a draftsman with the Cleveland Crane and Engineering Company from 1902 until 1903, when he became associated with Wellman-Seaver-Morgan Company. He also was employed with the Willard Storage Battery Company and the Jeffery Manufacturing Company of Columbus before joining American Steel and Wire. His first employment with the Wire Company was in 1905, when he began as a draftsman at the Newburgh Steel Works in Cleveland. He had been promoted to chief draftsman at Newburgh, before being transferred to Pittsburgh as an engineer in 1917. In 1922, he was appointed assistant construction engineer at Pittsburgh, and four years later was transferred back to Cleveland in the same capacity. The following year he became construction engineer of the Wire Company and in 1937 was appointed chief engineer.

Born in Wellsville, Ohio, Mr. Rose attended the township schoo and the high school at Wooster before matriculating at Case, from which he was graduated with a B.S. degree in mechanical engineering.

C. H. WILLIAMS was graduated from the University of Colorado in 1926 and was employed by Jones and Laughlin Steel Corporation as shear foreman in their Pittsburgh plant. In 1927 he became a junior engineer in the power department of National Tube Company Pittsburgh, shifting in 1930 to the Ohio Works of Carnegie Steel Company. Here he served successively as junior engineer, power and fuel engineer, and assistant chief engineer. In 1940 Mr. Williams was transferred to the Pittsburgh office of Carnegie-Illinois Steel Corporation as power and fuel engineer on the staff of the chief engineer, and was subsequently appointed assistant chief engineer of the Pittsburgh district. In 1941 he was placed in charge of a newly organized defense engineering staff to coordinate the engineering of defense steel plant expansions of the company in the Pittsburgh district. He was subsequently transferred to the United States Steel Corporation of Delaware as assistant to the vice-president of engineering, and in 1943 to chief engineer of the Pittsburgh district, Carnegie-Illinois Steel Corporation.

L. A. WYND served an apprenticeship with the Illinois Electric Manufacturing Company, Peoria, Illinois, at the same time attending night school at Bradley Polytechnic Institute. Enlisting in the U. S. Navy in 1911, he attended the naval electrical school at Brooklyn, finishing his enlistment in 1915. For the next two years he served as electrical inspector on ship installations in the Brooklyn navyyard. Returning to Peoria in 1917, Mr. Wynd worked as electrical construction foreman on the Keystone Steel and Wire Company's new mill. He became chief electrician in 1918, and served in that capacity until 1935, when he went with Republic Steel Corporation as electrical superintendent for their Chicago district.

A. J. FISHER was graduated from the Colorado State preparatory school and later from the University of Colorado, college of engineering, with a degree of M.E. in mechanical engineering. Mr. Fisher began his steel mill employment with the Bethlehem Steel Company at the Maryland plant as assistant master mechanic of the sheet and tin mill division in 1924. After serving in several capacities in various departments, Mr. Fisher became fuel engineer in 1929, holding that position at the present time.

H. W. NEBLETT, special engineer, Inland Steel Company, Indiana Harbor, Indiana, has been particularly concerned with power plant work and the development of new steel mill equipment.

Mr. Neblett's steel mill experience began with the Mark Manufacturing Company at Indiana Harbor, Indiana, in 1916. Later the name was changed to the Steel and Tube Company of America, the plant now being owned by the Youngstown Sheet and Tube Company. He was located with this plant from 1916 to 1920, as assistant electrical engineer. and from 1920 to 1922 he was electrical engineer at the Chicago office of the Steel and Tube Company of America. From 1922 to 1928 he was with the Colorado Fuel and Iron Company as engineer in charge of electrification of steel plants including power plants, the electrification of the existing mills and new mills that were constructed during that period. From 1928 to 1932 he was head of the Neblett Engineering Company in Chicago, a consulting engineering corporation dealing with the design and installation of steel mill equipment. In 1932 he went with the Inland Steel Company, Indiana Harbor, Indiana.

F. B. NIELSEN
DIRECTOR

GEORGE H. ROSE
DIRECTOR

C. H. WILLIAMS
DIRECTOR

L. A. WYND
DIRECTOR

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1938 L. F. COFFIN, *Superintendent*, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

1939 C. CLARKE WALES, Engineering Department, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

1940 J. A. CLAUSS, *Chief Engineer*, Great Lakes Steel Corporation, Ecorse, Michigan.

1941 W. A. PERRY, *Superintendent*, Electrical and Power Departments, Inland Steel Company, Indiana Harbor, Indiana.

1943 F. E. FLYNN, *District Manager*, Republic Steel Corporation, Warren, Ohio.

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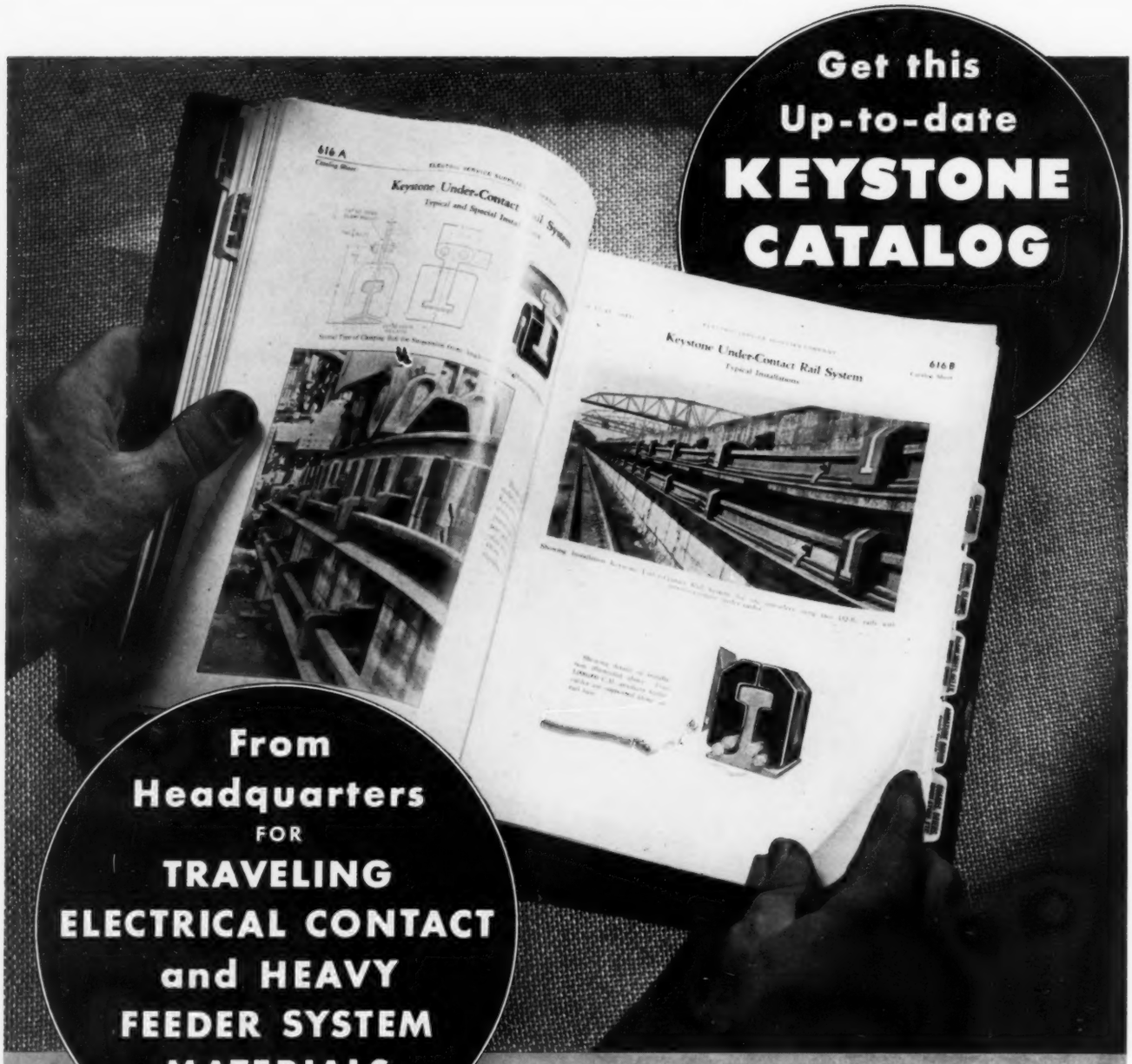

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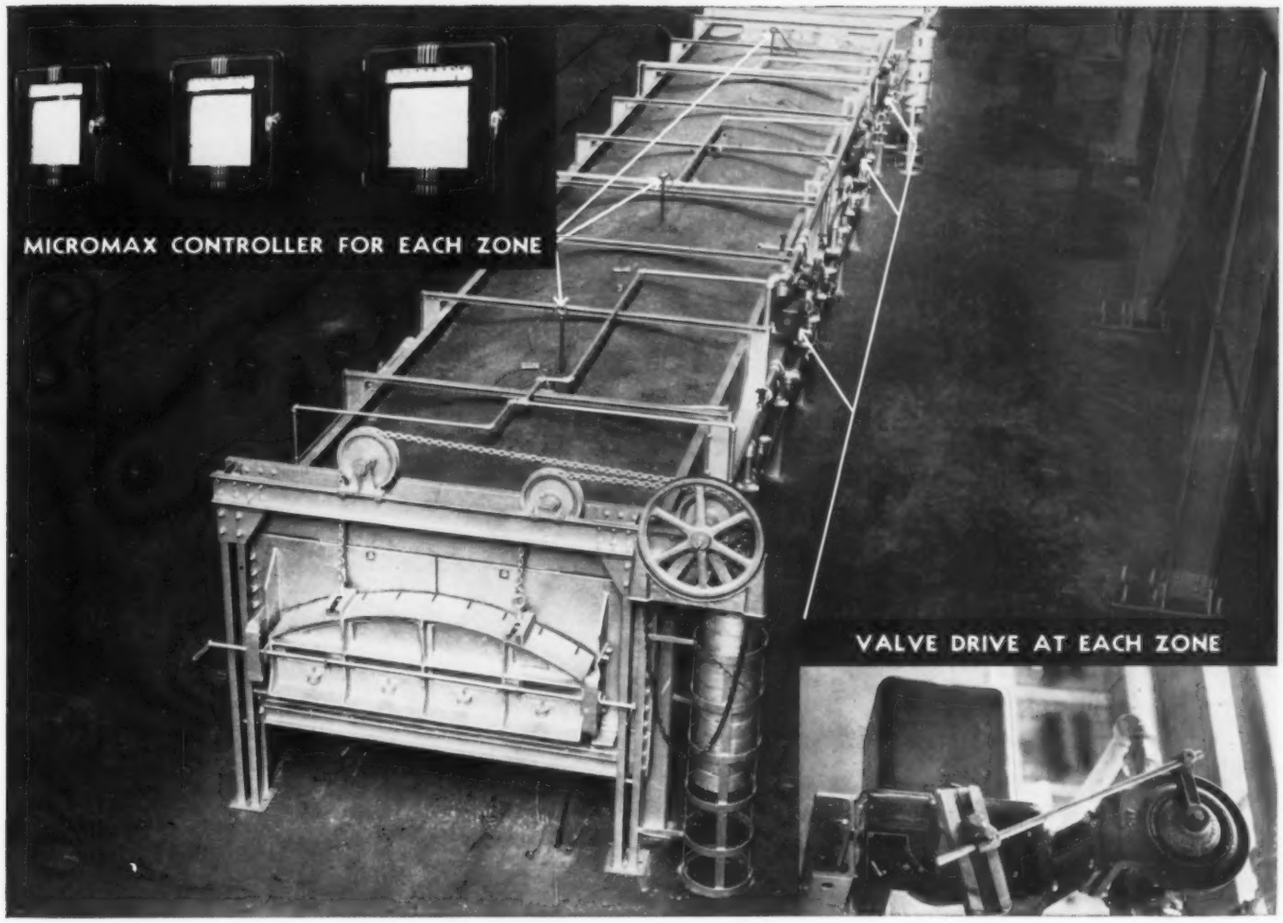

Gas-fired three-zone wire-patenting furnace, equipped with Micromax Electric Control for holding each zone at exactly the specified temperature.

OUTPUT OF COLD-DRAWN WIRE Is Speeded by Micromax Control Pyrometers

The furnace shown above has a vital war-time job — it is used for patenting, or specially-annealing, the Laclede Steel Company's hot-rolled rod, in preparation for the process of cold-drawing.

Patenting is an operation in which there's no such thing as too-close temperature control; the closer the control, the smoother and faster the drawing proceeds, and the longer the expensive drawing-dies can last.

Knowing this so well, Laclede's engineers picked Micromax Pyrometers to regulate the patenting temperature — to hold it as steadily on the mark as engineering skill and science will permit. And that's very close — so close that the Micromax chart records are sometimes almost ruler-straight for hours at a stretch.

If you could keep one eye on the Controller and the other on its fuel valve, you'd see how this evenness of regulation is maintained. You'd see the valve's position-pointer shift a bit toward the open or close position; yet the motion of the Controller's detecting mechanism might be so small you couldn't see it at first. There might be another valve-motion, or several more, before you could see that the pyrometer's record had been nudged ever so slightly out of line, and nudged back again as the change in fuel supply brought the temperature back to the control point.

That's what we call micro-responsiveness; the ability to act — correctly — when something tries to upset temperature. If the upsetting factor is small (a change in wind direction, perhaps), the correction is prompt but small. But if the upset is big, as when the furnace load is changed, the correction is both big and fast. Regardless of size, it's always in proportion, to hold temperature in the narrow path needed for high production of war goods.

If you have a furnace — whether for wire, or for cement, castings or anything else — on which you want highly dependable temperature control, tell us and we'll gladly try to help. Or, if you just want a Micromax catalog, ask for N-00A, "Micromax Electric Control."

Jrl Ad N-33A-626(2)

ARMY NAVY *depends on me!*

A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

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Exide-Ironclad efficiency helps break another bottleneck

Materials-handling could have been our biggest bottleneck . . . if it hadn't been for the efficient way in which Industry tackled the problem of labor shortages and increased shipping demands.

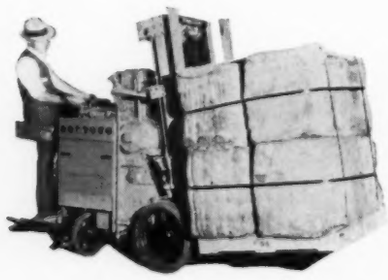
Right in the forefront is the job being done by Exide Batteries in helping speed materials along the production line. Efficient electric industrial trucks are powered with Exide-Ironclad Batteries for complete dependability. These sturdy workers help shift vital materials right through to every fighting front. Another potential bottleneck has been broken by American *know-how.*

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32

Exide Batteries of Canada, Limited, Toronto

EXIDE-IRONCLAD BATTERIES OFFER THREE VITAL POINTS OF SUPERIORITY

- MORE POWER, MORE PRODUCTION: An Exide-Ironclad delivers its power at uniform voltage to assure constant hauling speeds. There is always a giant surge in reserve when an Exide powers your battery propelled vehicles.
- LONG LIFE SAVES MATERIALS: Every Exide is built to last, and saves vital materials by squeezing the last ounce of use out of the materials in it. When you buy an Exide, you definitely . . . Buy to Last and Save to Win.
- EASY MAINTENANCE, SAVES LABOR: Exides are kept charged by the simplest method ever devised. With the Exide Charge Control Unit all you do is connect battery to the charging source and turn a knob.



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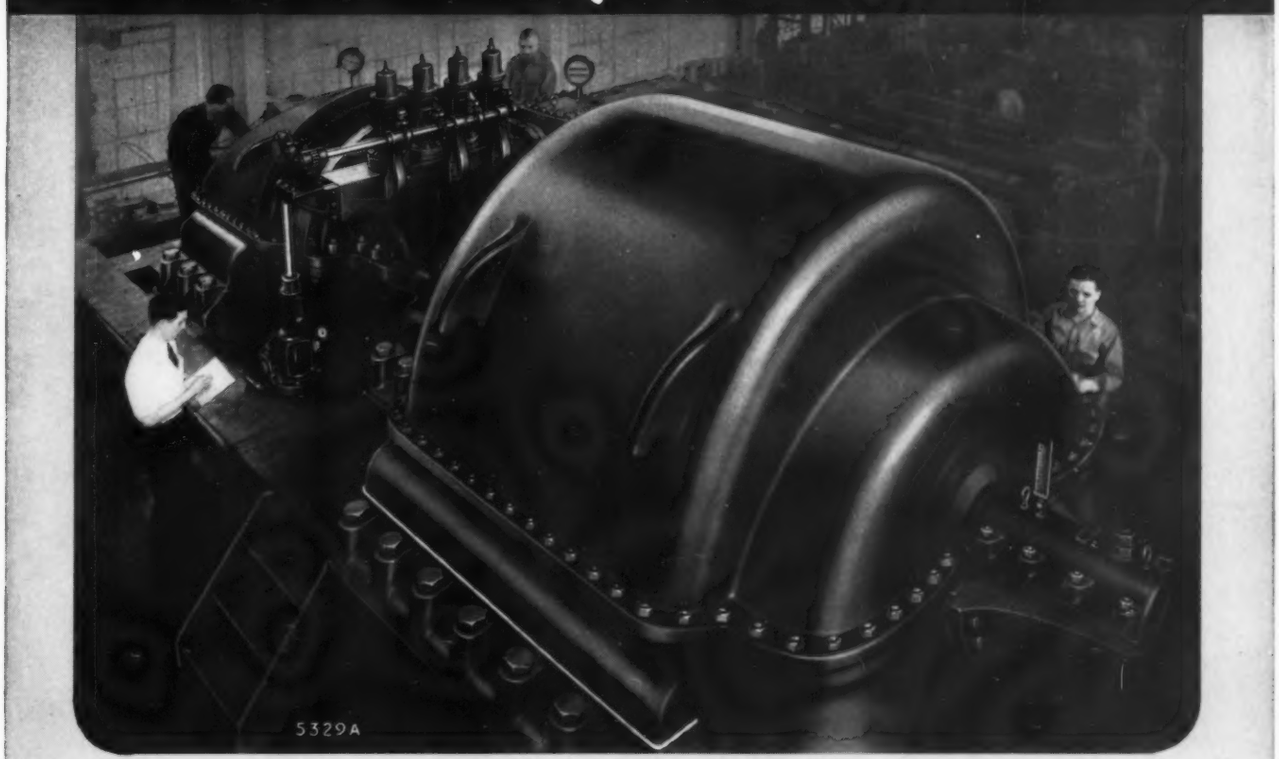
IRONCLAD BATTERIES

More Air to make More Iron to make More Arms



Turbine Driven Blast Furnace Blower on test in De Laval Shops

Three De Laval BLAST FURNACE BLOWERS of the latest design are being built at the De Laval Works; two of which are for a steel company already operating four De Laval blowers having an aggregate inlet capacity of 262,000 cu. ft. per minute against 30 lb. gage maximum pressure.

Each of the new machines is rated at 90,000 cfm. of air, as measured at standard conditions of 60° F. and 30 in. barometer, and to deliver against 30 lb. per sq. in. maximum pressure, with an actual capacity of 97,800 cfm. at normal operating inlet pressure and temperature conditions.

The units are controlled automatically to deliver a constant weight of air.

The design and materials for the driving turbines are suitable for operation with a maximum steam pressure of 700 psig and maximum temperature of 775° F.

3825

De Laval STEAM TURBINE CO.
TRENTON 2, N.J.

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC; PUMPS . . . CENTRIFUGAL, CLOGLESS, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, PROPELLER; PRIMING SYSTEMS; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS . . . WORM, HELICAL; and FLEXIBLE COUPLINGS

EDISON ALKALINE BATTERY *SURVIVES* FIRE & FLOOD

News from the Far North for Users of Industrial Trucks...

ADVANTAGES OF THE EDISON ALKALINE BATTERY IN INDUSTRIAL TRUCKS AND TRACTORS

★ It is durable mechanically. High strength steel construction is used in the containers, grids, pole pieces, etc. The electrolyte is a preservative of steel.

★ It is foolproof electrically. It may be accidentally short-circuited, over-charged, over-discharged, or even charged in the reverse direction without injury.

★ It can be charged rapidly. It is not subject to finish-rate limitations. It requires no equalizing.

★ It withstands temperature extremes. It is not damaged by freezing. Free air spaces on all sides of all cells provide ventilation for rapid cooling under high temperature conditions.

★ It is simple to maintain. Merely charge adequately, add pure water, keep clean and dry.

★ Its tray assembly and cell connections are extremely simple.

★ Its life is so long that its annual depreciation cost is lower than that of any other type of storage battery.

When a coal mine in Alaska caught fire recently, a 10-year-old Edison Alkaline Battery on a locomotive was trapped in the fire area. After the mine was flooded to put out the fire, the locomotive remained under water for nearly two months before it could be recovered.

When the battery was inspected, the tops of several cells were found to have been damaged by fire, but this was the only visible injury and required only minor repairs. Then the battery was given an electrical test. It delivered full rated capacity.

Although Edison Alkaline Batteries are not bought to withstand such abuse, the fact that they often do, in mines, railroads and industry, serves to demonstrate the great reserve of dependability which they have available under all conditions.

Some of the unique characteristics which account for the long life and dependability of the Edison Alkaline Battery are cited in the column at the left.

EDISON STORAGE BATTERY DIVISION, THOMAS A. EDISON, INCORPORATED, WEST ORANGE, NEW JERSEY

Edison

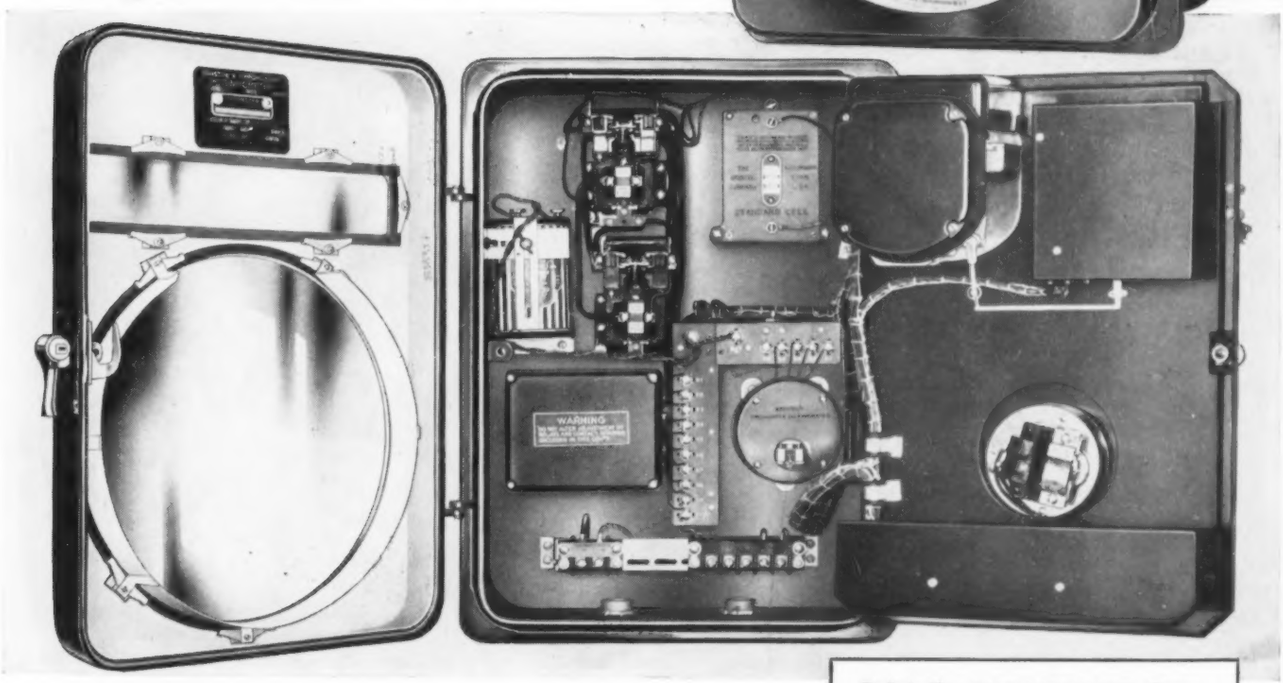
ALKALINE BATTERIES

Bristol's PYROMASTER

A Self-balancing Potentiometer for Recording, Indicating and Controlling Industrial Processes

REDESIGNED EMBODYING NEW FEATURES

1. Hinged panel for accessibility.
2. Standard Cell for accuracy.
3. High-torque motor for ruggedness.
4. Totally enclosed relays and galvanometer.
5. Enclosed tarnish-resistant slide-wire.
6. Large easily read straight-line scale.



Pyromaster Pyrometer Electric-Type Controller, door open and panel swung out

ALL PARTS ACCESSIBLE: All parts of the Pyromaster are accessible even when the instrument is in full operation. The dial and recording mechanisms are mounted on the front of a hinged reinforced steel panel, which can be swung out of the case as shown above. The slide wire and potentiometer mechanism and, in the case of controllers, the control mechanism are mounted on the back of the panel. Each part or unit can be serviced in place or removed without disturbing any other part.

Bristol's PYROMASTER Pyrometers are available in the following types of instruments for temperatures up to 3600° F.

Electric-Type Controllers
Air-Operated Controllers
Single-Pen and Two-Pen Recorders
Dial Indicators
Time-Temperature Controllers
Radiation Pyrometers

Complete facts in Bulletin P1200. Address 123 Bristol Road

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YOU GET THESE FEATURES IN P-G *Steel Grid Resistors*

★ All Steel Construction

★ Mica Insulation

★ Unaffected by Moisture

★ Provision for Expansion

★ Corrosion Resistant

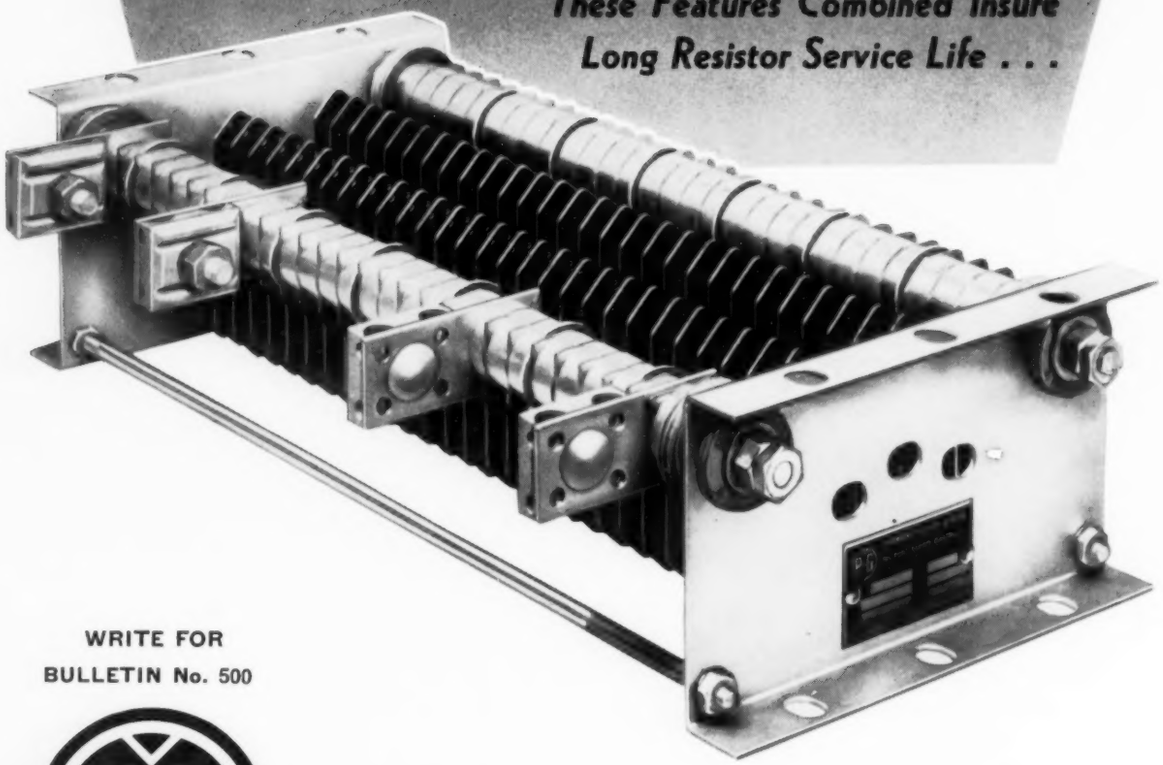
★ Maximum Ventilation

★ Constant Resistance

★ Withstands Vibration

★ Rugged Terminals

These Features Combined Insure Long Resistor Service Life . . .



WRITE FOR BULLETIN No. 500

P-G

"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY

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221 WEST THIRD STREET, CINCINNATI, OHIO

For Flexibility of Furnace Operation . . .

HIGH TEMPERATURES TODAY—

LOW TEMPERATURES TOMORROW—

BLOOM

Tempered-Flame

BURNERS

★ Provide uniform heating conditions

★ Avoid Large Temperature Differentials

★ Improve Quality of Workmanship

For general-purpose furnaces used in heat-treating, annealing, drawing, slow cooling, etc., Bloom TEMPERED-FLAME Burners provide controlled conditions for a wide variety of heating and cooling cycles.

For high temperature work, this burner provides all the advantages of long-flame combustion. When lower temperatures are wanted, excess air is introduced, heated and intimately mixed with the burning gas. This lowers the temperature without reducing the volume of gases, thus keeping the chamber at an even temperature throughout. Surprisingly low temperatures can be maintained, for this burner will stay lighted with 1000% excess air.

Perhaps Bloom TEMPERED-FLAME Burners will help you get better results. Write for full details.

BLOOM ENGINEERING CO.

857 W. North Avenue · · · PITTSBURGH, PA.

4 NEW BRUSHES

Photographs Courtesy Boeing Aircraft

AFTER DETERMINING the cause of brush failure at high altitude on aircraft equipment, the Research Laboratories of National Carbon Company, Inc., discarded the practice of treating brushes by impregnation and developed a type of brush composition which produces a protective film on the commutator and assures satisfactory commutation and brush life under all service conditions—from take-off to ceiling.

As a result of tests in actual high altitude flights, four grades have been developed with characteristics that cover practically every type of rotating electrical equipment used on aircraft. Although designed primarily for operation at the low temperature, low humidity and rarefied atmospheric conditions of high altitude, these brushes also show highly satisfactory performance under comparatively high temperature and high humidity conditions at sea level.

GRADE AJS – A specially bonded graphite grade for high altitude operation on medium and high voltage commutators of dynamotors, 30-volt motors and other aircraft equipment not subject to excessive temperature conditions. This grade has fairly high contact drop.

GRADE AJZ – A graphite grade containing 25% copper adapted to high altitude operation on aircraft motors, interpole generators and similar applications. The contact drop of this grade is lower than that of Grade AJS.

GRADE AJT – A high altitude metal-graphite grade containing 50% copper and with low contact drop, it gives excellent service on 30-volt aircraft equipment such as motors, amplidynes, inverters, low voltage commutators of dynamotors, interpole generators and slip rings. Used at current densities ranging from 160 to 200 amperes per square inch.

GRADE ALP – A metal-graphite grade with approximately 65% copper and very low contact drop, for low voltage dynamotor commutators on which brush performance is affected by high altitude and because of the need for a grade of still lower contact drop than AJT.

These brushes have been developed for military aircraft. Both now and after the war, the research facilities of National Carbon Company will continue preeminently qualified for solution of brush problems imposed by the unceasing development of all types of rotating electrical equipment.

★ *BUY UNITED STATES WAR BONDS* ★

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
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CARBON PRODUCTS DIVISION, CLEVELAND, OHIO
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30 East 42nd St., New York 17, N. Y.
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Want to *reduce* production costs?

Do you want to lay the foundation for your success in post-war competition? Start pruning the operating expense of heavy duty equipment. This is today's essential step toward the plant efficiency demands of peacetime business. It's an immediate help in war production. It's one problem that offers an efficient approach.

Mackintosh-Hemphill has been making industrial headlines since 1803. In their sphere of manufacturing, metallurgy and engineering, their services might prove of extreme value to you. They offer you an experienced source of advanced thinking.

THE ROLLS WITH THE RED WABBLERS

THEY ROLL MORE TONS PER GRIND

Install

Nironite C-B work rolls

Mackintosh-Hemphill has been the originator of practically every major roll development. Their Nironite Rolls, in actual service, have repeatedly demonstrated 300% greater wearing qualities than ordinary rolls.

M-H Nironite Rolls are high nickel chromium alloy iron, of the grain or indefinite chill type. The body surface structure very closely approaches that of true chill and the body centers and necks are tough and strong. They are ideal for flat work. These rolls are rapidly supplanting the true nickel chill types for Strip Mill Intermediates. They will not spall; give better finish and greater tonnage per grind. Because of their surface likeness to chill and freedom from spalling, the Hard Grade "D" is replacing Forged and Hardened Steel Rolls for Cold Work.

MACKINTOSH-HEMPHILL COMPANY

Pittsburgh and Midland, Penna.

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ONE HUNDRED YEARS AGO,

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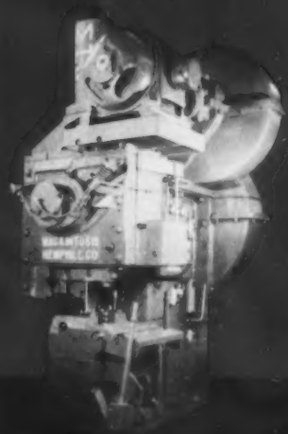

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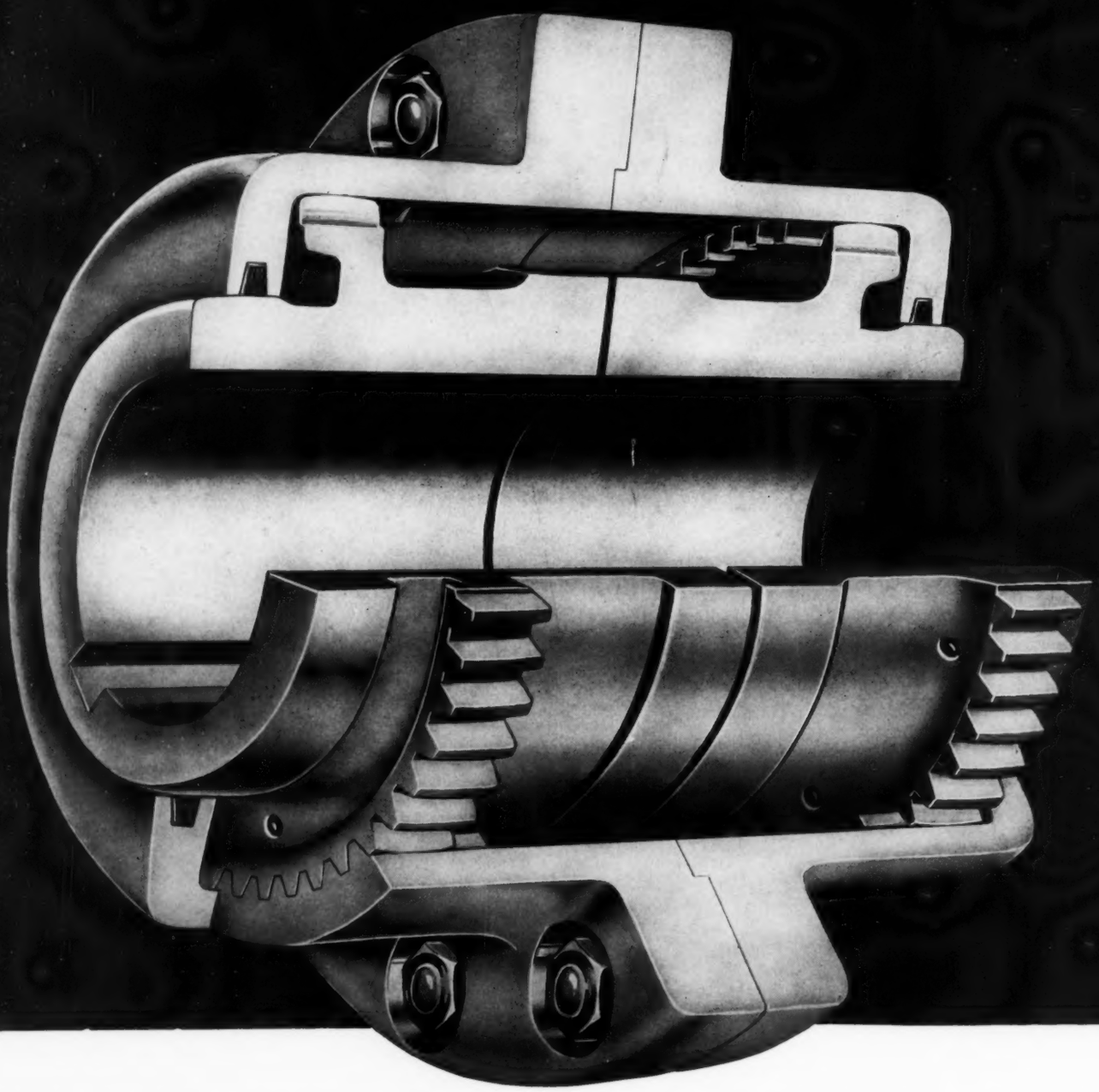
POOLE



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FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

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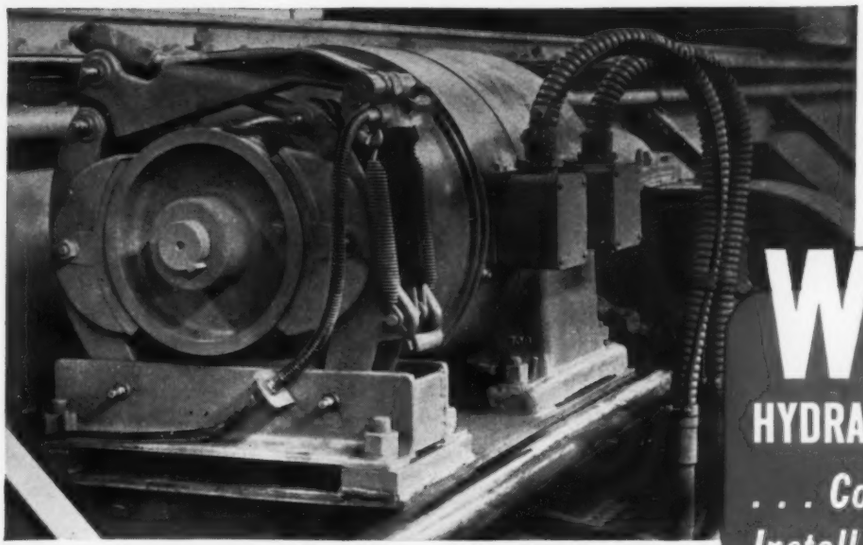


MODERNIZE YOUR CRANES *with* WAGNER HYDRAULIC BRIDGE BRAKES

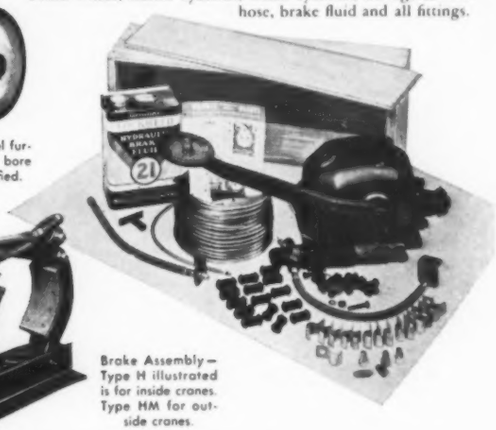
. . . Complete – Ready to Install on New or Old Cranes

Today, when every minute of production time is needed to hasten Victory, you cannot afford to neglect the efficiency and safety of your overhead crane brakes. The way to obtain "top" brake efficiency is to install Wagner hydraulic bridge braking systems.

Wagner hydraulic bridge braking systems come in two types: type H for inside cranes, and type HM for outside cranes where an automatic parking attachment is necessary. A few of the many points of excellence of Wagner hydraulic bridge braking systems are: — **1.** Easy one-point adjustment . . . **2.** Exclusive anti-drag device . . . **3.** Hardened pins, knurled to prevent rotation . . . **4.** Bushings at all points of maximum wear . . . **5.** Grease fittings on all hinge pins . . . **6.** Extra-thick friction blocks are bolted to the shoes . . . **7.** A nation-wide service organization through 25 branches.

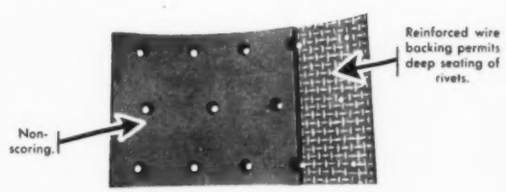
The complete system includes everything necessary – brake assembly, brake wheel, master cylinder, wheel cylinder, tubing, flexible hose, brake fluid and all fittings.

Brake Wheel furnished with bore as specified.



Brake Assembly – Type H illustrated is for inside cranes. Type HM for outside cranes.

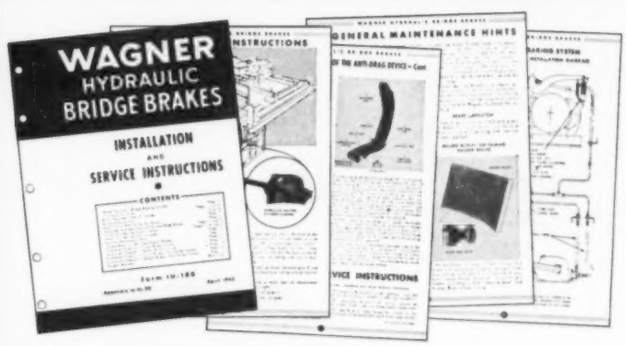
BRAKE LINING . .



Preformed in blocks to fit all makes and sizes of crane brakes.

Wagner molded wire-backed blocks have the following advantages: **1.** Non-abrasive – will not score brake wheels . . . **2.** Suitable for use with any type of brake wheel . . . **3.** Preformed to size and molded to wheel diameter . . . **4.** Wire-backed to permit deep seating of lining bolts or rivets . . . **5.** Molded blocks save installation time because they are easily applied . . . **6.** Available from Wagner branch stock . . . **7.** They reduce inventory by eliminating excessive stocks of roll-type lining which is generally purchased in long lengths in order to obtain the best price.

WAGNER INSTALLATION and SERVICE INSTRUCTIONS



Users of Wagner hydraulic braking systems, as well as every maintenance man responsible for the safe and efficient operation of overhead cranes, should have this bulletin on brake installation and service instructions. This new bulletin gives full installation and maintenance information and will be sent upon request. Write today for bulletins IU-18B and IU-20.

Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

143-4

This 26-inch Birdsboro Blooming Mill produces slabs from 1½" x 6" to 16" wide, or 100 sq. in., maximum thickness 9", and billets or blooms from 4" to 9".
BIRDSBORO
BIRDSBORO
More Ingot Blooms Per Shift

. . . and how Birdsboro built the mill to do it!

A serious bottleneck in steel production can develop if the blooming mill that forms and reduces ingots to useable shapes is not keyed to the tempo of today's urgent demands.

Birdsboro engineers, faced with the problem of building a blooming mill that would definitely step-up ingot blooming production, designed the two-high 26" rapid reversing mill you see here. Already it is smashing production records for mills of this type.

Designing better mill equipment and special machinery is an every-day job with Birdsboro engineering specialists. They have been tackling and solving such specialized problems for many years.

If you have a mill equipment or special machinery problem, it will pay you to consult Birdsboro. Take advantage of our complete engineering service, now.

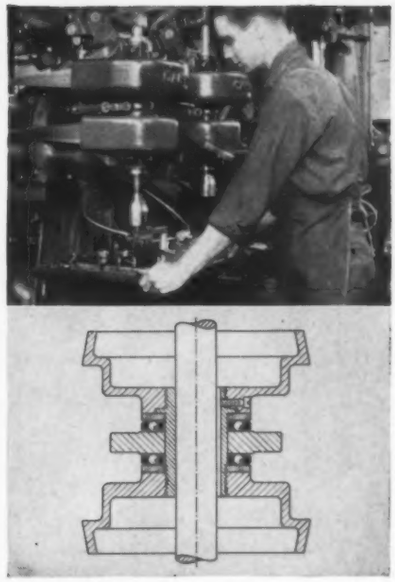
BIRDSBORO STEEL FOUNDRY AND MACHINE COMPANY, Birdsboro, Pa.

BIRDSBORO

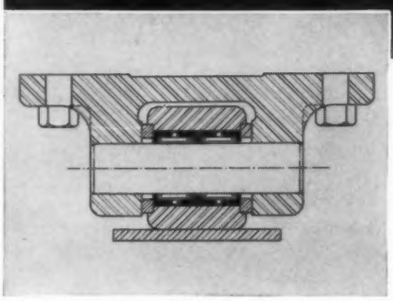
STEEL MILL EQUIPMENT

IN THE NEWS
WITH TORRINGTON BEARINGS

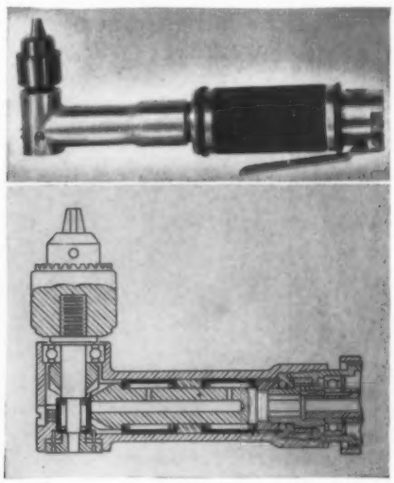
NAKED HULLS GROW INTO HUGE PBY Naval Patrol Bombers as they pass along the conveyor system of the production line at the Consolidated Vultee Aircraft Corporation. The hulls are supported on cradle-like dollies which move the ever-increasing load smoothly to its completion while removable sectional platforms provide ready access to the superstructure of the airplanes. To safeguard the vital wheel axles of the conveyor dollies so that the heavy load will be carried steadily and safely and without time-consuming stoppages, the makers of the conveyor system selected Type NCS Needle Bearings for their high capacity and low friction coefficient.



TAPPING OPERATIONS are done swiftly and accurately with this Garvin No. 2-X Duplex Automatic Tapper manufactured by the Western Machine Tool Works. The builders of this machine selected Torrington Ball Thrust Bearings for application on the spindle between the forward and reverse driving friction cones, as shown in the cross-section, because their sturdy construction and high accuracy could withstand the repeated shock loading which the application required.



"WORLD'S LARGEST" are these cold storage doors made by the Jamison Cold Storage Door Company for a 67° below zero cold chamber at Wright Field. To help support and lend ease to the operation of these colossal doors, a Needle Bearing equipped floor roller assembly has been applied to the bottom of the hinge sides, as shown in the cross-section, to provide ease of manual operation.



RIVET HOLES IN TIGHT CORNERS and small openings are easily drilled with this pneumatic angle drill made by the Chicago Pneumatic Tool Company. Because of their small size and high load capacity NCS Needle Bearings were selected to carry the load on the shaft of these compactly designed tools, as illustrated in the accompanying cross-section of the drill.

A COMPREHENSIVE LINE OF STANDARD ANTI-FRICTION Bearings—straight roller, tapered roller, needle, and ball—is offered by the Bantam Bearings Division. For new or unusual bearing problems, the assistance of Torrington-Bantam's engineers is especially valuable. Years of experience in the design and application of special bearing styles stand back of their recommendations. Whenever you need engineering counsel on standard or custom-built bearing types, TURN TO TORRINGTON.

ARMY ★★★ E ★★★ NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

POWERED BY PHILCO "XL" BATTERIES, TRUCKS

HAUL 10% MORE MATERIAL!

IN warehouses . . . embarkation ports . . . war plants from coast to coast, electric industrial trucks are handling materials with outstanding speed and efficiency.

Every day, more and more truck operators are selecting Philco "XL" Batteries because Philco-powered trucks will haul 10% more material!

Philco "XL" cells provide 10% extra capacity without increase in overall battery size! If your trucks have a man-sized job to do, specify Philco Batteries! For complete information and specifications, write for latest Philco Industrial Truck Battery catalog. *Philco Corporation, Storage Battery Division, Trenton 7, New Jersey.*

Wright-Hibbard High-Lift Platform Truck

Replace with

PHILCO BATTERIES

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Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

INLAND STEEL COMPANY ESTABLISHES MANY PRODUCTION RECORDS IN 1943

▲ New records in ingot production and finished steel shipments were established during 1943 by the Inland Steel Company.

Altogether, more than 200 new records were made at the company's Indiana Harbor plant last year. Included was a new all-time monthly high in the shipment of plates.

Inland produced during the twelve months ending December 31 a total of 3,597,975 net tons of ingots, an increase of 170,464 net tons over the 1942 total. In the same period it shipped 2,727,398 net tons of finished steel, 116,674 net tons more than were shipped during 1942.

Company officials commented that there had not been a single interruption, day or night, during the year in its making of steel.

The new all-time monthly high in plate shipments is represented in the 91,693 tons shipped in December. The previous all-time high mark for a similar period was made only a month before when 88,958 net tons were shipped. The November record in itself was considered remarkable at the time it was made.

Indicative of the performance in plate shipments was the fact that in 1943 a total of approximately 1,000,000 net tons was shipped, in comparison with a rated capacity before the war of 307,000 tons. With maritime and navy plate requirements for ships being particularly emphasized, Inland went "all out" in its 1943 production and shipments of plates. Slightly more than one-third of the plate shipments was exclusively for maritime and navy ship requirements.

Practically all shipments were maintained according to promises made, insuring customers against the necessity of cutting down on fabricating lines because of delays.

Major improvements at Indiana Harbor during the year included:

The placing in operation of two batteries of coke ovens, one blast furnace, dock and ore facilities, a power plant and accessory facilities which Inland had undertaken to build for the Defense Plant Corporation.

Construction by Inland's blast furnace department of additional sintering plant equipment.

A water tunnel, approximately 200 feet below the surface, built by the power department to furnish clean water for the No. 2 power station.

A new billet processing department in the 40-inch blooming mill, consisting of mechanical chipping and pickling equipment.

Increased ore unloading facilities, including a new ore bridge, on the ore unloading dock.

KOBUTA PLANT OPERATES ABOVE RATED CAPACITY

▲ Built by the Koppers Company for Defense Plant Corporation and operated by Koppers United Company, the recently completed Kobuta development is one of the largest plants furnishing materials for the nation's synthetic rubber program. The Kobuta plant does not make synthetic rubber, but produces butadiene, through the catalytic conversion of

Production at Kobuta of butadiene and styrene for synthetic rubber is exceeding rated capacity by about 50 per cent.

ethyl alcohol, and styrene by cracking ethylbenzene. These two products are shipped separately to outside plants where they are combined by polymerization into synthetic rubber.

The Kobuta plant contains four butadiene units, as well as one continuous styrene unit. Rated capacity, 80,000 tons of butadiene and 37,500 tons of styrene per year, is being exceeded by approximately 50 per cent. Raw materials consist principally of about 9,000,000 gallons of alcohol and 1,000,000 gallons of benzene per month.

More than 1,000,000 lb of steam are generated in four 700 psi boilers. Steam is passed through a 35,000 kw topping turbo-generator and on to the steam-consuming processes in the plant. Power generation is tied into the public utility system in an interchange arrangement.

One of the striking features is the extent to which steel was eliminated in the construction of the plant. Pipe lines are supported on wooden poles or reinforced concrete A-frames. Stairs, handrails, etc. are for the greater part of wood. The boilerhouse is entirely of reinforced concrete construction.

THOMAS
FLEXIBLE
COUPLINGS
5 exclusive Thomas features
★ NO BACKLASH
★ NO WEAR
★ NO LUBRICATION
★ NO THRUST
★ FREE END FLOAT
These are the five essential features for a permanent care-free installation not found in any other make or type of flexible coupling.
For specifications on couplings for all standard purposes write for the new Thomas Catalog with complete engineering data.
"BUILT TO LAST A LIFETIME"
THOMAS
THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA
C-5

SHEAVE DESIGN REDUCES SHAFT OVERHANG

▲ A new sheave, designed for quick and easy mounting and demounting, has just been announced by the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

Known as the "Magic-Grip" sheave, it locks to shaft in one tightening operation. As its tapered split bushing, which accommodates normal shaft tolerances, is drawn further into sheave, sheave, bushing and shaft are locked together simultaneously. This positive clamp fit makes sure that the "magic-grip" sheave is perfectly centered and secure . . .assuring smooth running performance free from backlash and shear.

The company states that the new design of the "magic-grip" permits sheave to be mounted closer to motor . . . increasing bearing life by reducing shaft overhang. They will be stocked in a complete line at no increase in price.

More complete information concerning "magic-grip" sheaves may be obtained by writing for Bulletin B-6310. Allis-Chalmers, Milwaukee 1, Wisconsin.

PIG IRON PRODUCTION STARTED AT GENEVA

▲ Pig iron production was begun January 4 at the government's new $180,000,000 steel plant near Provo, Utah, with the blowing in of the first blast furnace. This plant is operated for the government by Geneva Steel Company, U. S. Steel subsidiary.

This blast furnace, embodying the most modern features of design, is one of three which have been erected at western America's largest integrated steel mill. Each furnace has a daily capacity of 1100 tons of iron.

Construction of the plant for the government was begun by Columbia Steel Company, west coast subsidiary of U. S. Steel, in April, 1942. In August of this year, Geneva Steel

Company, a newly formed U. S. Steel subsidiary, contracted with Defense Plant Corporation to operate this great war plant for the duration without profit or fee.

Iron ore was brought to Geneva from Columbia Steel Company's open pit iron mine near Cedar City, Utah. An automatic conveyor-stacker is used to bed down the ore at the plant in neat elongated piles to assure a uniform iron content when it is fed into the blast furnaces. Coke is being produced in the coke by-products ovens at Geneva which began operations December 14, using coal from the newly developed Geneva mine in southeastern Utah. Limestone and dolomite, other raw materials used in smelting iron ore, are obtained from Keigley quarry, a part of the Geneva project located 25 miles from the plant.

CONTROL HAS STARTING, INTERRUPTING FEATURES

▲ A new control, designed for synchronous and induction motors, the E-M Hi-fuse control combines dependable starting service with short-circuit protection through the use of split-cycle-operating, high-interrupting capacity power fuses.

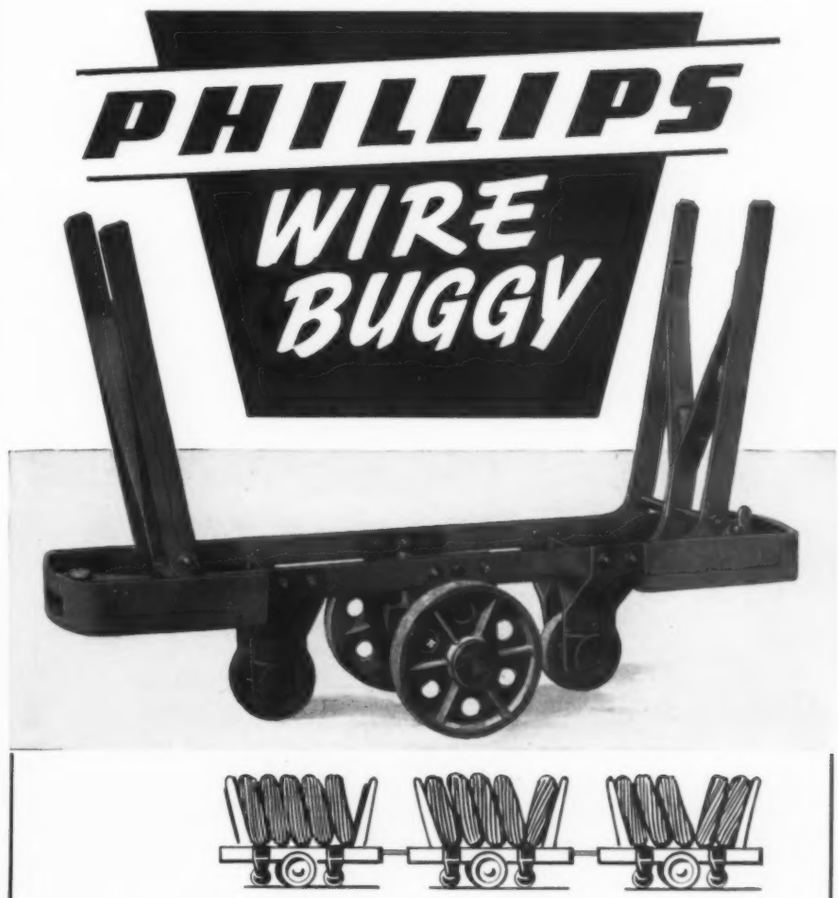
This new control is available in metal-enclosed design as shown here, or in live-front or dead-front types.

Because of the split-cycle speed with which the fuses clear fault current, and the action of the fuse to limit current, the motor switch, while amply strong to withstand the momentary fault current, does not have to be of the more costly high-interrupting capacity type. Thus, by means of the fuses, high-interrupting capacity is provided at a moderate cost — and the fuses also serve as power disconnects.

The control affords complete protection for the motor against abnormal operation in starting or running. For synchronous motors, the control provides an exclusive feature in the E-M polarized field control. This simple, accurate polarized relay gives smoothness and maximum power in synchronizing the motor.

Hi-fuse controls can be furnished in live-front or dead-front, as well as the metal-enclosed type illustrated. Disconnect compartment doors are open to show fuses. Write for free copy of publication 172 for further details.

Electric Machinery Manufacturing Company, Minneapolis 13, Minnesota.



THE Phillips Wire Buggy adds a *busy worker* to your Annealing Furnace operations. Easily adaptable to trailer use and quickly couples in train form . . . also a practical answer for wire storage. Write for data.

MANUFACTURERS SINCE 1863

PHILLIPS MINE AND MILL SUPPLY COMPANY

PITTSBURGH, PENNA.

MINE & INDUSTRIAL CARS—FABRICATED STEEL—IRON CASTINGS

It's hard to believe, but here it is: A steam switching locomotive that carries no fire, makes no smoke, and does its work with no more noise than a gentle exhaust of steam! The Porter Fireless Locomotive operates on heat energy stored in its tank. The heat is supplied by excess steam from your stationary boilers. The Porter Fireless is so easy to handle, new unskilled employees—even women—can quickly learn to run it. Practically 99% availability. Few wearing parts make the maintenance expense almost negligible.

ONLY PORTER BUILDS A COMPLETE LINE OF LOCOMOTIVES

H. K. PORTER COMPANY, INC.
PITTSBURGH, PENNSYLVANIA
PITTSBURGH, PA. BLAIRSVILLE, PA. *FACTORIES:* NEWARK, N. J. NEW BRUNSWICK, N. J.

ARMY NAVY

LOCOMOTIVE DIVISION:
Diesel, Diesel-Electric, Electric, Steam, and Fireless Steam Locomotives.

PROCESS EQUIPMENT DIVISION:
Agitators, Mixers, Blenders, Autoclaves, Kettles, Pressure Vessels, Driers, Ball and Pebble Mills.

QUIMBY PUMP DIVISION:
Screw, Rotex, Centrifugal, Chemical, and Steam Pumps.

ORDNANCE DIVISION:
Projectiles, Heavy Forgings, Breech Blocks.

PORTER "Better Built" Equipment
Established 1866

HIGH SPEED OPERATION WITH NEW CONTROL VALVE

▲ An unusually compact solenoid air control valve which can be operated at sustained speeds up to as high as 400 reversals per minute is a late development.

This newly designed valve, known as Ross model No. 835, is a ¼ in. heavy duty, solenoid operated, 4-way valve for the control of double-acting cylinders; it may also be used as a 3-way valve by plugging one outlet. This valve is the same poppet type principle that the company has been building for the past 20 years.

Unusually compact, this solenoid air control valve can be operated at speeds up to 400 reversals per minute.

Overall dimensions of this model No. 835 are length 7 in., width 3½ in., height 5¼ in. Other noteworthy features are its low current consumption, noiseless operation and long life.

Detailed information will be sent on request to the manufacturer, Ross Operating Valve Company, 6498 Epworth Boulevard, Detroit 10, Michigan.

COKE OVEN CONSTRUCTION ACTIVE IN 1943

▲ Eighteen batteries of Koppers-Becker coke ovens, totaling 1,142 ovens with an annual coal carbonizing

STEEL MILLS BID FAREWELL TO BRASS

With reductions in the manufacture of shell and cartridge cases, Weirton Steel Company leaves the ranks of the brass industry in which it has temporarily enjoyed the position of sixth largest processor. Weirton's entry into brass rolling was occasioned by the brass industry's casting capacity outgrowing the rolling capacity. Turning to the steel industry, Army Ordnance Department officials put the problem up to Weirton, who, after a study of the shell case industry and some preliminary experiments, developed a satisfactory procedure for hot rolling, scalping and cold rolling. The extra capacity afforded by the steel mills for the rolling of brass is no longer needed, but the proof furnished by Weirton that it could be done is comforting knowledge.

capacity of 9,196,000 tons, were completed or under construction by Koppers Company, engineering and construction division, in the United States, Canada and Brazil during 1943.

Largest of the coke oven projects is that for the new Geneva Steel Company plant at Geneva, Utah. One battery of 63 ovens is in operation, and three batteries of 189 ovens are ready for operation. The four batteries will have a total carbonizing capacity of 1,766,000 tons.

One of three batteries, totaling 171 ovens, for the Bethlehem Steel Company, at Lackawanna, New York is operating, with two still under construction. They will have a total capacity of 1,363,000 tons. A battery of 70 ovens, with 703,000 tons capacity, was completed for the Bethlehem Steel Company at Steelton, Pennsylvania.

Another project of more than a million tons capacity was completed for Inland Steel Company, at Indiana Harbor, Indiana. Two batteries totaling 146 ovens have a capacity of 1,185,000 tons.

At Sault Ste. Marie, Canada, a battery of 86 ovens with a capacity of 766,000 tons, was built for the Algoma Steel Corporation, Ltd.

Other projects completed were: Republic Steel Corporation, Cleveland, one battery, 75 ovens, 665,000 tons capacity; Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama, one battery, 73 ovens, 550,000 tons; Donner-Hanna Coke Corporation, Buffalo, New York, one battery, 15 ovens, 114,000 tons.

Other projects now under construction are: Lone Star Steel Company, Daingerfield, Texas, one battery, 78 ovens, 633,000 tons capacity; Colorado Fuel and Iron Company, Minnequa, Colorado, one battery, 74 ovens, 500,000 tons; Sheffield Steel Corporation, Houston, Texas, one battery, 47 ovens, 383,000 tons.

Near completion is a battery of 55 ovens for the new plant of the Brazilian Steel Company, Volta Redonda, Rio de Janiero, Brazil. The ovens have a rated capacity of 570,000 tons.

PLATE SET SYSTEM EXPEDITES PUNCHING

▲ Announcement of Wales plate set system for punching holes in flat material has been made by George F. Wales, president of the Wales-Strippit Corporation, North Tonawanda, New York.

Ampco Screw Down Nuts, made by the centrifugal casting process.

Avoid costly breakdowns—with parts of AMPCO METAL for these heavy-duty services

1. *Screw Down Nuts:* The strength and toughness of Ampco enables it to stand up under the tremendous unit pressures transferred to the screw threads, where ordinary bronze fails. Sizes up to several thousand pounds.

2. *Universal Joint Bearing Segments:* These slippers, made of Ampco, withstand not only the severe pressures and shock, but also the abrasive action of the powdered steel scale.

3. *Many Other Services:* This remarkable alloy of the aluminum bronze class is widely used for many other mill applications where lubrication is available and there is need for high impact strength or outstanding bearing qualities. Consult your nearest Ampco Field Engineer, or write for Engineering Data Sheets 38 and 73. AMPCO METAL, INC., Dept. IS-1, Milwaukee 4, Wis.

AMPCO Reg. U.S. Pat. Off.

Metal

The Metal without an Equal

NEW COKE PLANT SPEEDS UP WAR PRODUCTION

Spurred by heavy demands for steel and chemicals needed in the war effort, the new coke and chemical plant of the Pittsburgh Steel Company at Monessen — the only plant of its type constructed in southwestern Pennsylvania since 1930 — is operating at peak capacity. Helen Dudick, one of many women employed at the plant, is shown operating a device to drench and cool the hot coke with water before it is carried by conveyors to railroad cars. The plant not only is producing coke for the company's blast furnaces, but also millions of cubic feet of gas, valuable oils and chemicals.

This system covers the use of Walesite plate sets with Wales PS punch assemblies and dies. Punch assemblies and dies may be used and reused in an unlimited number of plate sets because they are manufactured in standard sizes for quick interchangeability.

With this system, holes may be punched in any pattern in sheets up to 43 in. x 45 in. The minimum center-to-center hole location is ½ in. in any direction.

Each Walesite plate set consists of two plates which are made of Walesite, a plastic material uniquely applicable to this new method of hole punching. These are separated by spacer bars, also of Walesite material, and are held together rigidly by bolts and dowel pins.

Wales adjustable feed carriages carry, nest and remove blanks in and out of the plate set assemblies faster and with a greater safety factor to operator. Feeding and removing blank with this carriage require only a flip of the hand. These carriages are adjustable for width (left to right), to permit use in any size plate set assembly.

For complete information, write to the Wales-Strippit Corporation, North Tonawanda, New York.

The most effective defense against leakage on all vital flow-lines in steel plants

—for controlling gas, oil, residues, air and water

Sizes: ½" to 30".

—for all temperatures

—all pressures

NORDSTROM *Lubricated* **PLUG VALVES**

Leaking valves are the saboteurs of production. Keep flow lines flowing by installing positive action, positive sealing Nordstrom Valves. Keep upkeep down.

Nordstroms meet every major valve need. Lubrication under pressure keeps these valves in prime condition, making them easy to turn, and also sealing the ports against leakage.

MERCO NORDSTROM VALVE COMPANY *A Subsidiary of Pittsburgh Equitable Meter Co.*

Main Offices: 400 Lexington Ave., Pittsburgh, Penna. Branch Offices in Principal Cities

NEW RECORDS AT JONES & LAUGHLIN

▲ Operating at 102 per cent of capacity for 1943 to produce a record tonnage of steel for war the Jones and Laughlin Steel Corporation announced recently that its works at Pittsburgh, Aliquippa, and McKeesport, Pennsylvania, and Otis Works, Cleveland, Ohio, had broken 598 production records during the year.

At Pittsburgh Works, 42 yearly production records were broken, including the best previous records of the blast furnaces, open-hearth and bessemer departments, the blooming mills, the rolling mills, the 96-inch strip-sheet mill and the cold finishing mills.

At Aliquippa Works 19 yearly production records were broken, including the best previous records of the blast furnaces, open-hearth and bessemer departments, the blooming mill, the 14-inch mill, the 30-inch round mill, the no-lap welded and the seamless tube mills.

At Otis Works, Cleveland, 10 yearly production records were broken, including the by-product coke department, No. 2 blast furnace, sinter plant, open-hearth department, the 77-inch strip mill and the plate mills.

The McKeesport Works bettered 3 previous yearly records for the production of war material.

22,743,000 TONS OF INGOTS FOR CARNEGIE

▲ Carnegie-Illinois Steel Corporation set a new production record of 22,743,000 ingot tons during 1943. This tops the previous record set in 1942 by enough extra tonnage to build the hulls of 164 LST's, the tank landing craft which are now being constructed in various shipyards under top priorities for the invasion fronts.

In addition to the overall steel record made by this U. S. Steel subsidiary, new high marks in 16 blast furnace units and 25 steel-producing units were set during the year. There were also 33 new annual Carnegie-Illinois records made by rolling mills, 13 by miscellaneous producing groups and one by coke oven units.

During December a new company monthly record production of over 1,150,000 tons of coke was established by company plants at Clairton and Chicago. At the same time the No. 3 blast furnace at Clairton Works and No. 2 blast furnace at Duquesne Works set new monthly marks.

Rolling mill records at the Gary Works 36-inch slab mill and No. 18 mill at McDonald Works at Youngstown, Ohio topped their best previous monthly marks set in November, 1943.

MOTOR NOR CORROSIVE, DUSTY ATMOSPHERES

▲ The Crocker-Wheeler Division of the Joshua Hendy Iron Works announces the release of their Sealed-power, corrosion-resistant motor. This motor is suitable for operation in atmospheres containing injurious dusts, corrosive vapors or gases, and excessive moisture, such as are often encountered in chemical plants, textile mills, food plants and mines.

CROUSE-HINDS
Type WMK Enclosed Safety Switch Condulet

- **Raintight.** For use in all indoor and outdoor non-hazardous locations. Also suitable for Class III and IV hazardous locations. *NEMA Types 3 and 5.*
- **Feraloy cases.** Strong and durable. Four sturdy mounting feet. Many possible conduit arrangements for both horizontal and vertical through feed.
- **Safety.** Positive interlock prevents opening the case unless switch is "off."
- **Padlocks.**
  1. Cover may be padlocked to prevent unauthorized entry.
  2. Operating handle may be padlocked "on" or "off."
- **Threaded operating shaft.** Bearings permanently lubricated. Resists corrosion. Prevents the entrance of dust and moisture.
- **Switches.** Quick make and break mechanism. Double break, reinforced, positive pressure-type blade and jaw construction. Positive pressure fuse clips. Combination solder or solderless wire lugs.
- **30, 60, 100, or 200-Ampere.** 1 to 50-H.P.
- **125 to 600-Volt, A. C.**
- **2 or 3-pole,** fusible or fuseless.

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS, manufactured only by CROUSE-HINDS, are the Standard of Quality in the field of electrical conduit fittings.

CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U.S.A.

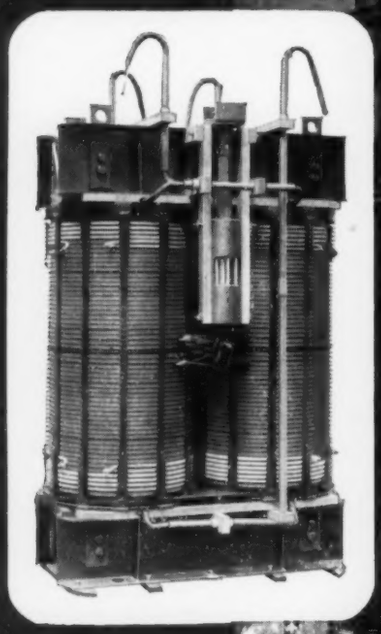
Offices: Birmingham — Boston — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington

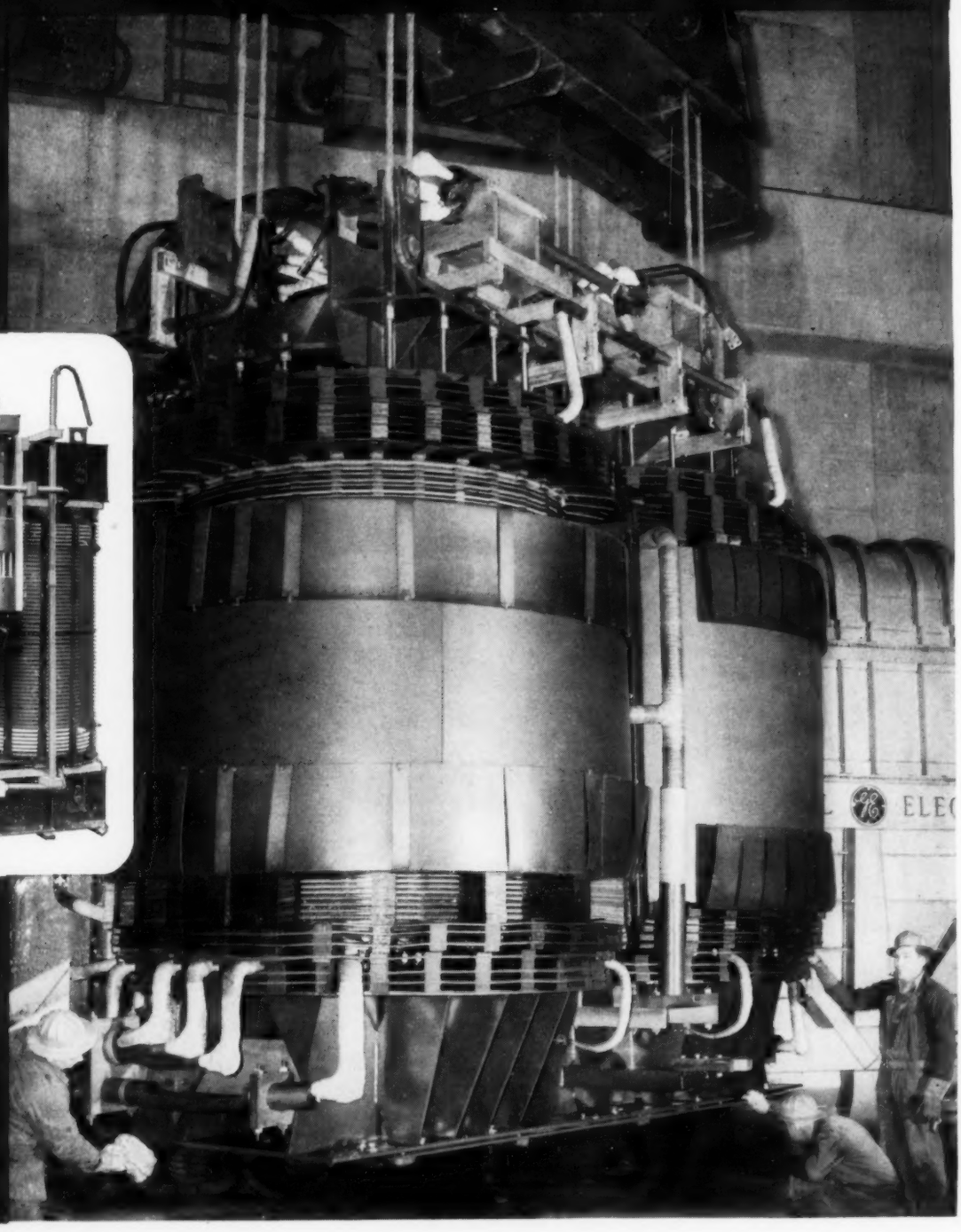
Resident Product Engineers: Albany — Atlanta — Charlotte — New Orleans

CROUSE HINDS COMPANY OF CANADA, LTD. *Main Office and Plant:* TORONTO, ONT.

SHIELDED WINDINGS

TWO TYPES OF SHIELDING: (Right) Single-phase, 36,000-kva, 230,000-volt transformer with shields surrounding high-voltage windings. (Below) Single-phase, 26,600/46,000Y-volt transformer with shields at top and bottom of each high-voltage coil stack.





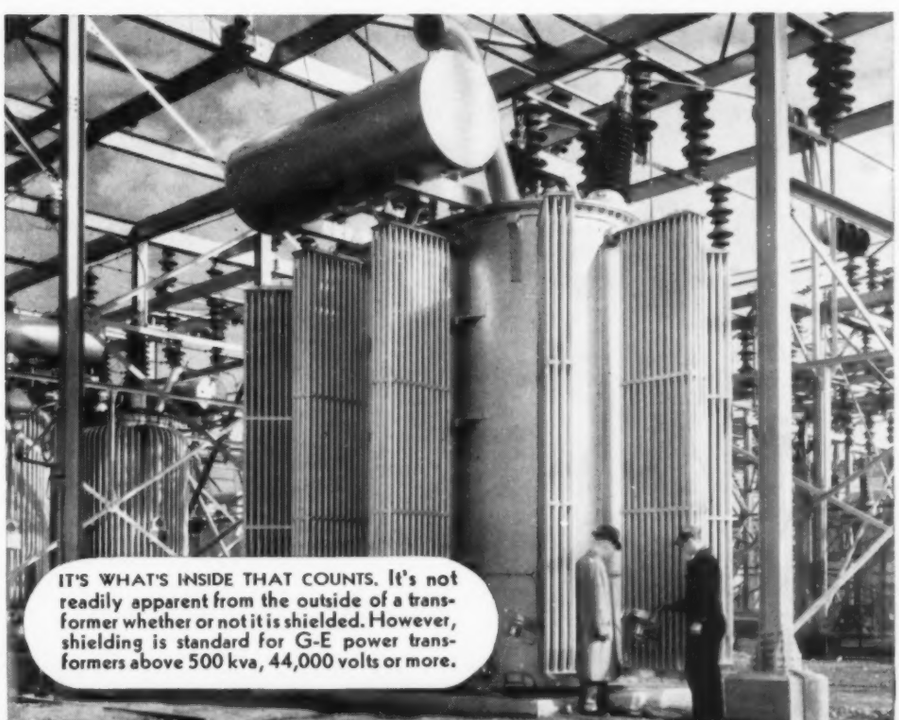
POWER TRANSFORMERS

for Real Protection of 3-SHIFT POWER for War Production

2500 IN SERVICE Wherever G-E shielded-winding transformers are supplying power—for the production of vital war goods or for the home—they are helping to ensure service continuity.

The G-E shielded winding has proved to be the most nearly perfect means yet devised for preventing concentrations of voltage stress within power transformers, which might be caused by switching surges or lightning impulses. Shielding enables the transformer designer to know definitely the maximum stress for which he must insulate at each point throughout the winding.

More than 2500 G-E shielded transformers, totaling more than 21,000,000 kva, installed over a period of 16 years, are now serving the war effort. *General Electric Company, Schenectady, N. Y.*



IT'S WHAT'S INSIDE THAT COUNTS. It's not readily apparent from the outside of a transformer whether or not it is shielded. However, shielding is standard for G-E power transformers above 500 kva, 44,000 volts or more.

GENERAL ELECTRIC

401-14-5155

What Is a Shielded Transformer?

A transformer is called "shielded" when its winding is equipped with properly insulated metallic surfaces, *connected to the line terminal*, and so proportioned as to effect a radical reduction in the lightning stresses inside the winding.

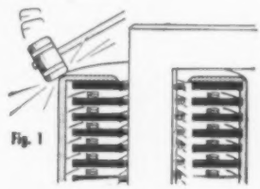


Fig. 1

Why Does Shielding Reduce Lightning Stresses?

Fig. 1 illustrates the effect of a sudden blow on a brittle mechanical structure protected by a steel shield that envelops the corner of the structure. The shield distributes the force of the blow over a sufficient area to *prevent concentration* of stress at any point, enabling the structure to stand, without damage, a blow that would otherwise be destructive. In a similar way, the shield shown in Fig. 2 envelops the corner of the transformer winding and *prevents concentration* of lightning voltage.*

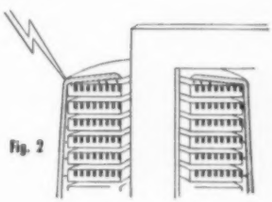


Fig. 2

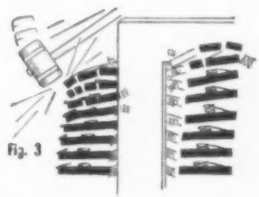


Fig. 3

In Fig. 3, the same mechanical structure, but without shield, is destroyed by a blow of the same severity, because of *concentration* of mechanical stress at the point of impact. This compares with the unshielded transformer winding subjected to lightning impulse, as shown in Fig. 4.

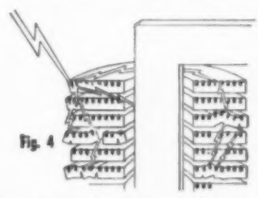


Fig. 4

The G-E shielding principle is as simple as it is effective. External application of the shields permits the retention of all the desirable features of G-E circular-coil construction. For a complete description ask for Bulletin GEA-2305.

**Voltage concentration at the end of the winding also causes internal oscillations which produce high-voltage concentrations within the winding, comparable in severity with the initial impact. These oscillations, too, are prevented by shielding.*

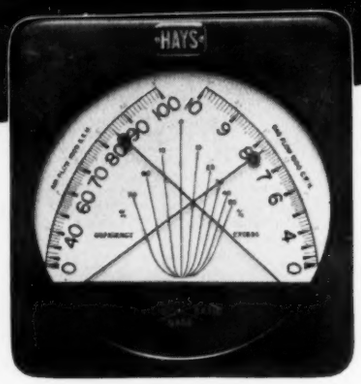
Available in sizes from one to fifteen horsepower, the Sealedpower motor can be furnished for operation from any polyphase power supply.

The Sealedpower motor is of the totally enclosed, fan cooled type, but the design departs from previous models in that there are no cooling ducts to become fouled with wet or sticky dusts. All exposed parts of the corrosion resistant model are acid and alkaline resistant to a high degree.

In laboratory tests, the Sealedpower motor was operated on an intermittent cycle while drenched in water for forty-eight hours without failure. In a second test, fine chalk was introduced into the test chamber for several hours without penetration into the motor.

In addition to the mechanical sealing of the entire motor, each coil is individually sealed against moisture, fumes, vapor and dust by the vacuum impregnation process.

Are you interested in Saving



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It saves in fuel because it indicates instantly when there is an incorrect proportioning of air and fuel. It is an infallible guide to highest possible combustion efficiency.

It saves in material through producing greater uniformity in production methods, in minimizing spoilage, etc. It may be used for indicating not only the ratio of air flow to fuel flow—but the ratio between other functions such as pressure, draft, suction, temperature (up to 1000° F) speed in R.P.M. or inches per minute, position, level and others.

The cross-pointer feature is exclusive with the Hays Visio-Ratio Gage. It shows at a glance not only the amount of the two flows but the percentage of excess or deficiency existing between them.

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New Literature

▲ Surface Combustion, Toledo, Ohio, has issued a 4-page folder SC-115 entitled "Surface Combustion Carbottom Furnaces." Copies of this bulletin are available upon request. Write directly to the company at Toledo, Ohio.

▲ I-T-E Circuit Breaker Company, Philadelphia, Pennsylvania, has issued a 34-page catalog No. 1002. Copies of this may be obtained by writing directly to I-T-E Circuit Breaker Company.

▲ The Youngstown Welding and Engineering Company, Youngstown, Ohio, has an interesting, new 16-page catalog. It shows many photographs of a wide variety of welded steel crates, baskets, chains, and accessories which are used in connection with pickling, enameling, and heat treating operations. The purpose of the catalog is not only to show the wide variety of equipment that is available, but to also give the readers many pictures from which they may get good, new production ideas. Anyone may receive one of these catalogs promptly by writing to the company.

▲ The fundamentals and the various applications of electronic control are interestingly described in a new 12-page bulletin (GEA-4126) recently issued by the General Electric Company.

Well illustrated, the publication explains in clear, simplified language the fundamental principles of electronic tubes and their operation, describes the construction of the well known thyratron tube, and lists the functions of eight of the more widely used industrial-type tubes.

The publication also describes and illustrates many practical applications of electronic control, including rectification, resistance welding, timing, and processing operations, as well as photoelectric installations involving counting, sorting, weighing, measuring, registering, illumination, and the control of cement kiln temperatures. Many of these applications have been in successful operation for a decade or more.

▲ A new, twenty-four page, nontechnical booklet covering all types of plastics, their uses, and general information on the plastics industry has just been released by The Richardson Company, Melrose Park, Illinois.

This illustrated book explains the

host of properties which fit Insurok and other plastics to the wide range of present and postwar uses. The limitations of plastics are also covered.

The two main groupings of plastics, Thermosetting and Thermoplastic, are described and illustrated in layman's language. Special sections are devoted to the forms of plastics, laminated and molded. The manufacturing and production processes of each are well illustrated.

The book is designed primarily for the non-technical man who may be serving on his company's postwar product committee and is desirous of obtaining a general knowledge of plastics and their applications. Copies are available only to those who write for them on their company letterhead to: The Richardson Company, Department 100, Melrose Park, Illinois.

▲ Fifty-six diagrams, so-called "S-Curves," have been brought together in the new Atlas of Isothermal Transformation Diagrams published by the United States Steel Corporation. Each "S-curve" represents the time of response of a particular steel to specified conditions of temperature and therefore serves as a map to guide the practical man to the proper heat treatment of each of these steels.

These diagrams represent the results of a systematic experimental investigation which has been carried out over the last fifteen years at the Research Laboratory of the United States Steel Corporation at Kearny, New Jersey, and is still being continued. The booklet, which will be distributed to war material producers who are users of steel, to metallurgists and technologists in industrial and educational laboratories, and to others interested, has been termed a significant contribution by U. S. Steel to the science and practice of ferrous metallurgy.

In the practical heat treatment of steel, as ordinarily conducted, the steel is first heated to a temperature higher than its so-called transformation temperature at which the carbon goes into solution, and then it is cooled in some specified way, as by quenching in water or oil, or allowing it to cool slowly in the furnace. In this process the step which most significantly influences the properties developed in the steel is the initial rate of cooling, which is a matter of both temperature and time; because of this the results are difficult to

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Flexibility of movement is possible since the squirrel cage motor is housed in a free turning shell with anti-friction bearings and a minimum number of rotating parts. When the electric current is disconnected, each "Motor-Roller" acts as an idler Roller.

Schloemann experience and skill are also utilized in the engineering of extrusion presses, air hydraulic accumulators, accumulator controls, and complete hydraulic systems.

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interpret usefully in general terms. This difficulty can be obviated by separating the effects of temperature from those of time at temperature; and this separation is the fundamental idea on which these diagrams are based.

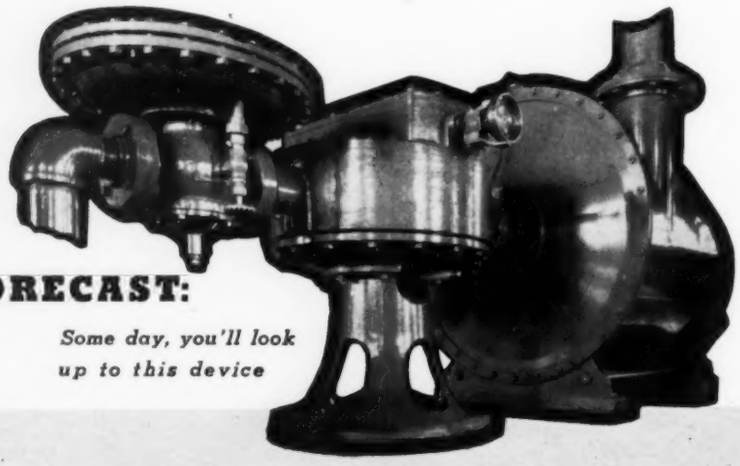
Each set of observations shows the sequence of events when the previously heated steel is not cooled continuously, but quenched to a certain temperature level and held there; and the diagram summarizes the results of such constant-temperature or isothermal transformation over the range of ordinary heat-treating conditions. Publication of these diagrams from time to time in individual articles and papers has resulted in their widespread use by metallurgists, heat-treaters and welding engineers. The collection in this atlas was designed to meet the considerable demand for the diagrams of a large number of steels, by reproducing them in a form and size convenient for practical use.

The fifty-six diagrams included in the booklet represent a total of 47 different compositions selected from a larger group for which information was available. They are grouped in seven sections with each group preceded by a few remarks pertinent to it. The sections are separated by standard charts in blank, inserted for the convenience of those who may wish to construct a diagram from other data. The booklet also contains editorial material on the significance of the isothermal transformation of a steel, explanation of a typical diagram, and a selected bibliography listing 34 studies in the field.

▲ "Porter Steam Locomotives," a new catalogue giving technical data on the most complete line of industrial locomotives built in the United States, as well as railroad switching locomotives, has been announced by H. K. Porter Company, Inc., Pittsburgh, Pennsylvania. Latest in a series dating back 75 years to when Porter began locomotive manufacture, the catalogue represents an authoritative review of the current field of industrial and switching steam engines. More than 50 locomotive types are illustrated, with complete specifications and performance data given in the majority of cases. Articles on standard specifications, tractive force, and the most modern procedures in locomotive operation are illustrated with mechanical drawings and tables. Porter methods and materials used in locomotive construction from frame to cab are reviewed in the 68-page booklet.

▲ Catalog 42B, recently issued by Metallizing Engineering Company, Inc., 38-14 30th Street, Long Island City 1, New York, describes Metco metallizing guns, wires, surface preparing tools and other metallizing accessories in detail. In addition, it tells how sprayed metal coatings are saving critical materials and manpower in the production and maintenance of war-needed parts and equipment.

The above company is also offering a limited number of copies of its 80-page metallizing handbook to present and potential users of the metallizing process. Profusely illustrated with photographs and diagrams, this handbook covers every phase of the process, from surface preparation to spraying techniques and the finishing of sprayed metal coatings. Price $1.00 postpaid.



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This is the patented, exclusive Kemp Industrial Carburetor, the machine that provides complete premixing of gas and air to provide new savings, new heat liberation, new flexibility and new control in almost every type of ferrous and non ferrous heat processing.

As the basic unit in Kemp heat treating the Industrial Carburetor supports gas immersion melting in modern tin stacks, provides fuel for inert gas and for recirculating radiators in annealing covers, for Kemp Radiatube Roll Heaters, may be set for exactly the desired flame characteristics whether reducing, oxidizing or for complete combustion . . . and save 15 to 40 percent in fuel.

For engineering details and assistance, address **The C. M. Kemp Manufacturing Company, 405 East Oliver Street, Baltimore, Maryland**

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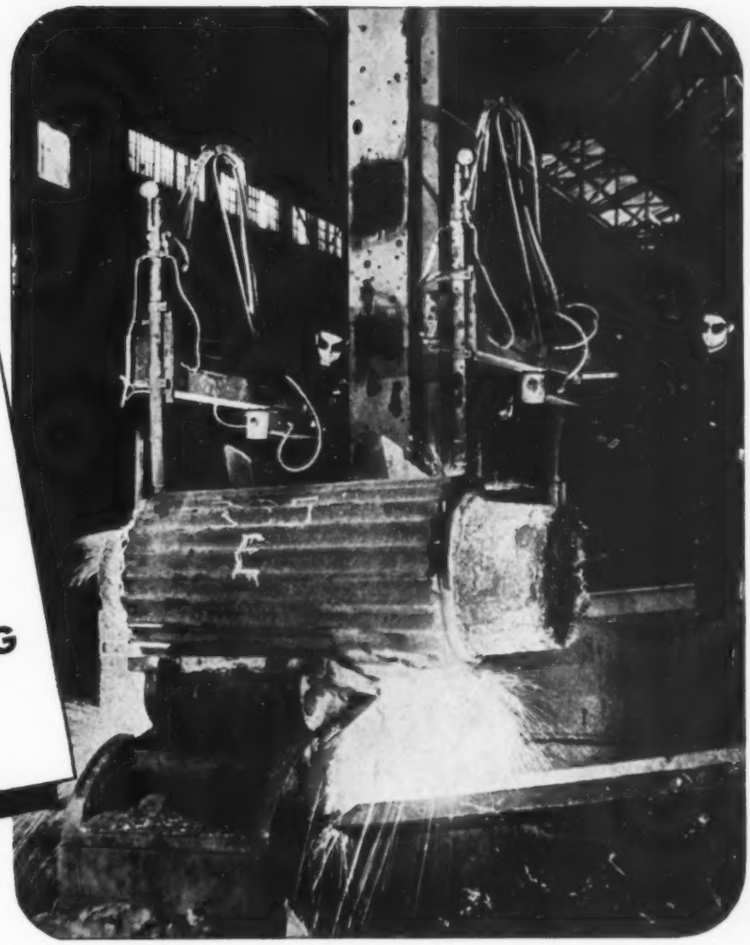
KEMP of BALTIMORE

36" Ingots CROPPED IN 8 to 10 Minutes —THANKS TO AIRCO ENGINEERING RESEARCH



Until recently cropping corrugated ingots was a slow operation, requiring many man hours and considerable press time.

Then one steel mill operator, anxious to speed up operations to keep pace with mounting war orders, asked Air Reduction engineers to help find a faster ingot cropping method. Machine gas cutting had stepped up many slow manufacturing jobs — why couldn't it expedite ingot cropping?

Air Reduction's Research department set to work on the problem. They developed an effective solution in the "tailor-made" ingot cutting machine, shown above.

With this machine, tapered corrugated ingots as thick as 36" in diameter are cropped in an average of 8 to 10 minutes instead of the many hours formerly required. Moreover, this machine cuts off both ends of the ingots simultaneously. As a result, a troublesome production bottleneck has been eliminated and ingot cropping costs have been materially reduced.

This case like many others demonstrates how Air Reduction's Research and Engineering departments helps customers to achieve faster production through more efficient use of oxyacetylene processes. In addition to providing oxygen guaranteed 99.5% pure, Air Reduction offers all its customers the services of an experienced technical staff skilled in the application of oxyacetylene flame and electric arc processes. This nation-wide Airco engineering service is available through any Air Reduction office.

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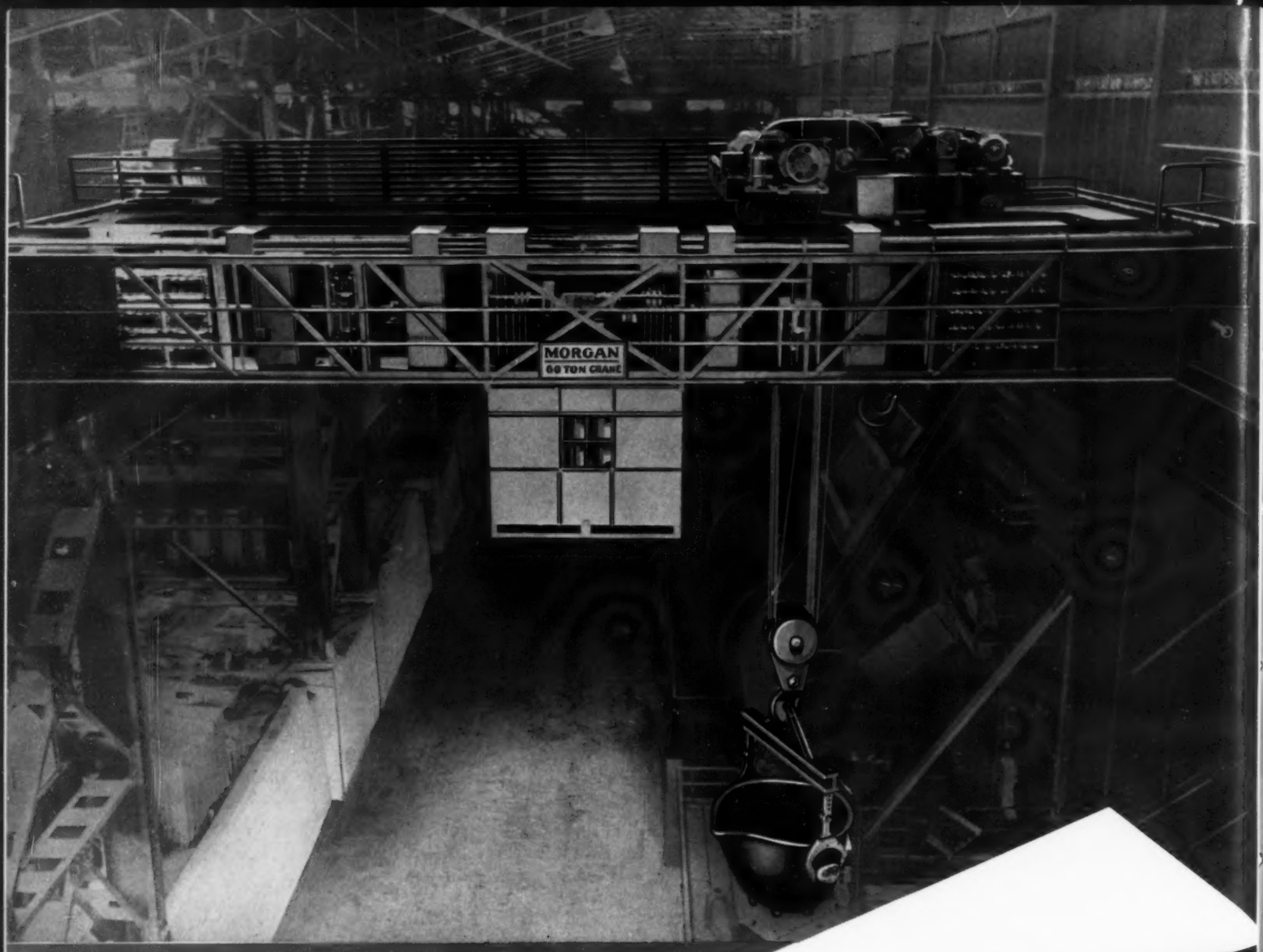

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SPAN CONVERTER AISLE CRANE**

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● Illustrated is a Morgan heavy duty mill type crane in a converter aisle. It is equipped with fabricated welded trolley and bridge trucks; hydraulic bridge brake and anti-friction bearings. Trolley is of the gear box type having two 60-ton identical hoists using plain motors with flexible couplings. An auxiliary girder is provided for supporting the center cage. As a safety feature, special relays are incorporated in the control circuit to limit the torque of the hoist motors when "pulling collars." On such crane equipment for copper smelter service, the stability of Morgan Engineering has long been well established.

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ITEMS OF INTEREST

John E. Angle has been appointed assistant general superintendent of the Gary sheet and tin mill of Carnegie-Illinois Steel Corporation, United States Steel Corporation subsidiary, it was announced recently.

In his new position Mr. Angle succeeds **C. A. Ferguson** who was recently promoted to general superintendent of the sheet and tin mill. Following his graduation from Lehigh University in 1932, Mr. Angle began his service with United States Steel Corporation as a junior metallurgist in the Gary plant. In 1935 he became chief metallurgist and then served in other executive positions.

JOHN E. ANGLE

Ralph P. Deputy has been promoted to division superintendent of the sheet mill, succeeding Mr. Angle.

Mr. Deputy started his service with the corporation in October, 1912, at the Gary sheet mill. After a year's service with another U. S. Steel subsidiary, Columbia Steel Company at Torrance, California, he returned to the Gary sheet mill in 1933 as sheet mill finishing department superintendent, the position he has held until the present promotion.

E. J. Anglin has resigned as vice president in charge of operations of the Weirton Steel Corporation, a subsidiary of the National Steel Corporation, it was announced recently, but will continue in the employ of the company as general consultant. Mr. Anglin has been succeeded as vice president in charge of operations by **J. S. Williamson,** former general superintendent.

E. W. Rieger, former assistant to the president, has been appointed vice president in charge of engineering and development work.

W. A. Murphy has been appointed vice president and also will continue to serve in the capacity of secretary.

J. J. Munns was appointed vice president in charge of quality control.

C. E. Bayer, former manager of the steel works department, has been appointed general superintendent, and **E. O. Burgham,** former manager of the Weirton tin mill, has been appointed assistant general superintendent.

Other appointments include **P. R. Church,** former assistant manager of the steel works department, who is now manager of the steel works department, and **C. E. Carr,** former assistant to the manager of the steel works department, who is now assistant manager of that department. **A. E. Kadell,** former manager of the Steubenville tin mill, is now manager of the Weirton tin mill, and **C. M. Eddy,** who was assistant manager of the Weirton tin mill, has been appointed manager of the Steubenville tin mill.

J. D. Gold, former chief metallurgist, is appointed assistant vice president in charge of quality control and its supplemental departments.

S. M. Newbrander, former first assistant metallurgist, succeeds J. D. Gold as chief metallurgist.

A. N. Swanson has been appointed chief process metallurgist in the Chicago metallurgical division of Carnegie-Illinois Steel Corporation. He is succeeded in the position of chief metallurgist at the Gary works of Carnegie-Illinois Steel Corporation by **C. J. Hunter,** formerly co-ordinator of armor plate products for the corporation in the Pittsburgh general office.

H. R. LOXTERMAN

H. Russell Loxterman has been appointed engineer in charge of sales of Blaw-Knox furnace equipment throughout the middle west. His office will be in the Peoples Gas Building, Chicago. Mr. Loxterman has been in charge of similar work in the Pittsburgh district and is a graduate of Carnegie Institute of Technology.

George H. Sambrook has been appointed safety director of the H. C. Frick Coke Company and United States Coal and Coke Company, U. S. Steel subsidiaries, it was announced recently. He succeeds Clyde L. Lutton who retired as of December 31, 1943 after 26 years of service. Mr. Lutton will be retained temporarily in an advisory capacity.

Mr. Sambrook first began his employment with this organization in 1920 as a payroll clerk after serving in the United States Army during World War I. He then

progressed through promotions to the positions of fire boss, assistant mine foreman, mine manager, mine inspector, and on January 1, 1941 was appointed assistant safety director, which position he held at the time of his recent appointment.

Carl E. Haugh has recently been appointed chief engineer for the Martins Ferry division of Blaw-Knox Company.

Mr. Haugh has been supervising engineer for Armco International Corporation; assistant consulting engineer for Continental Ordnance Corporation; assistant plant engineer for the United Engineering and Foundry Company; chief draftsman for H. A. Brassert and Company; chief draftsman for Republic Steel Corporation, Warren, Ohio; and chief draftsman for the Universal Atlas Cement Company, Buffington, Indiana.

CARL E. HAUGH

He has also been employed as mechanical engineer for H. A. Brassert and Company in Chicago, Illinois; Republic Steel Company, Cleveland, Ohio; Wisconsin Steel Company, South Chicago, Illinois; American Sheet and Tin Plate Company, Gary, Indiana; Inland Steel Company and Republic Steel of East Chicago, Indiana.

Mr. Haugh has attended both the University of Illinois and Northwestern University, graduating at the latter school in 1929.

The Martins Ferry Division machines, assembles, tests and delivers to the U. S. Navy the 40 mm Bofors anti-aircraft gun mount, known as "The Queen of the Navy," in Naval Ordnance.

Robert Murray has been appointed assistant division metallurgist of the American Steel and Wire Company, Cleveland, Ohio, U. S. Steel Corporation subsidiary.

Born in Paisley, Scotland, Mr. Murray has been a United States citizen since 1920. He received his education in Paisley and at Glasgow Technical College. His first employment with the Wire Company was in October, 1920, as a sample clerk at South Works in Worcester, Mass. In February, 1922, he was transferred to New Haven as a pyrometer checker in the patenting and galvanizing department. He worked his way up through the ranks and was named assistant superintendent in August, 1938, and superintendent in February, 1941, which post he has held to the present time.

Edwin E. Caspell has been named superintendent of the New Haven works, succeeding Mr. Murray.

Mr. Caspell was born in Cleveland, Ohio, and was educated in the public schools there before entering the University of Cincinnati College of Engineering from which he was graduated with an M.E. degree. He worked for various Cleveland plants of American Steel and Wire for numerous short periods while attending college and upon his graduation became permanently associated with the company when he was made a technical apprentice at New Haven in November, 1932. He has held various positions and since August, 1938, has been general foreman of the rope mill at New Haven.

Arvin P. Wiedemann has been made general foreman of the rope mill at New Haven, replacing Mr. Caspell.

Mr. Wiedemann was born in New York City and is a graduate of Yale University, having received a B.A. degree. He has been associated with the American Steel and Wire Company since March, 1937, and since April, 1940, has been assistant general foreman of the rope mill at New Haven.

E. C. Ostlund has been appointed assistant chief industrial engineer of the American Steel and Wire Company, U. S. Steel subsidiary, with offices in Cleveland, Ohio.

Mr. Ostlund has been associated with the American Steel and Wire Company since October, 1936, when he was made an industrial engineer in the Worcester district manager's office. He has held other industrial engineering positions and since November, 1940, has been works industrial engineer at South Works.

Evarts C. Hall has been named works industrial engineer at South Works, Worcester, Massachusetts, succeeding Mr. Ostlund.

Mr. Hall first started working for the company in November, 1936, in the Worcester district industrial engineering department. He has been works industrial engineer at North Works, Worcester, since December, 1942.

Frank F. Marquard, general superintendent of Clairton works, Carnegie-Illinois Steel Corporation, retired January 1, 1944 after more than 45 years of continuous service with U. S. Steel subsidiaries.

Mr. Marquard was born in Cleveland, Ohio in 1875, received his public school education in Dayton, Ohio, and graduated from Ohio State University in 1896 with a degree in civil engineering. After graduation, he entered the Case School of Applied Science in Cleveland for a post graduate course in chemical engineering.

National Steel Company, Sharon, Pennsylvania, gave Mr. Marquard his first job in 1898. He was employed there as a chemist and in 1900 accepted the position of chief chemist and metallurgist in a new steel plant at Farrell, Pennsylvania, which was later purchased by the United States Steel Corporation. Mr. Marquard was made superintendent of construction and later superintendent of U. S. Steel's first by-product coke plant which was erected at Farrell.

In 1915 Mr. Marquard worked with engineers who built the Clairton by-product coke plant, was made

PEACE

★ With this issue of the IRON and STEEL ENGINEER we start a new year, perhaps a year that will see peace and joy return to the world and mankind.

To our many friends and associates in the steel industry who are playing such an important part in bringing about this inevitable peace, we send the warmest greetings for continued health and success.

TRUFLO FAN COMPANY · HARMONY, PA.

THE WAPAKONETA MACHINE CO.
Incorporated 1891 — Wapakoneta, Ohio.

superintendent of this plant in 1916 and general superintendent of the Clairton steel plant, by-product coke works and river transportation department in 1933, the position he held until his retirement.

Mr. Marquard developed many original processes in the manufacture of sheets and by-product coke during his long service with the company, advances in manufacturing which have been adopted as standard practice by other manufacturers of steel and by-product coke.

Hobart W. Seyler has been appointed general superintendent of Clairton works, effective January 1, 1944, it was announced by Carnegie-Illinois Steel Corporation. He succeeds Frank F. Marquard.

Mr. Seyler was born in Batavia, Ohio, and was educated at Ohio State University, receiving his degree in chemical engineering in 1919. After graduation he was employed as chemist at the Clairton works, and in 1926 became chief chemist. He continued in that position until 1936, at which time he went to New York City to serve in the by-products sales offices of U. S. Steel at 71 Broadway.

After one year in New York, he was called back to the Clairton works as superintendent of the coke plant. In 1939 he became assistant general superintendent of the Clairton works and held this position until his present appointment.

Working in close cooperation with Mr. Marquard, Mr. Seyler was responsible for many improvements in the quality of coke and in the development of by-products of the coke ovens.

He holds an honorary professional degree in chemical engineering, awarded in 1939 by Ohio State University.

David P. Finney has been appointed assistant general superintendent of the Carnegie-Illinois Steel Corporation's Clairton works, succeeding Hobart W. Seyler.

Mr. Finney began his service with this U. S. Steel subsidiary plant in 1916 as test puller and chief clerk at the Clairton steel works physical laboratory. In 1918 he was transferred to the Clairton by-product coke plant and in 1922 was promoted to superintendent of the coke handling department. He became assistant superintendent of the coke plant in 1937 and was made division superintendent of the by-product coke plant in 1939, the position he held at the time of his appointment. He is a member of the U. S. Steel coke committee and of the Carnegie-Illinois blast furnace and coke oven committee.

James McIntosh, formerly superintendent of coke plant operations has succeeded Mr. Finney as division superintendent in charge of coke plant operations, He began his service with the company in 1905 at the Edgar Thomson Works, Braddock, Pennsylvania, where he held various operating positions. From 1915 until 1916 he was employed at the Farrell works coke plant, and was transferred to Clairton works at the time construction work was begun on the coke plant there. He successively became superintendent of the oven department, superintendent of ovens and heating, and superintendent of coke plant operations.

George M. Carvlin has been elected vice-president of Koppers Company, engineering and construction division, it was announced recently.

Mr. Carvlin had been an assistant to Joseph Becker, vice-president of Koppers Company and general man-

ager of the division, since 1940. He started with Koppers as a research engineer in 1925, later serving in the operating and sales departments.

His first position after being graduated from the University of Illinois in 1922, with a degree in chemical engineering, was with the Corn Products Refining Company, New York. He left that firm after three years to join Koppers.

Mr. Carvlin was born in Chicago in 1900, and attended public schools there.

Ralph L. Wilson, former chief of the Constructional Steels Section of the Metallurgical and Conservation Branch, Steel Division, of the War Production Board in Washington, D. C., has been made chief metallurgical engineer of The Timken Roller Bearing Company, Canton, Ohio.

Mr. Wilson, 44, is a graduate of Central High School, Canton, Ohio, and of Lehigh University ('21), where he received the degree of electrometallurgist.

His experience includes 6 years with the metallurgical departments of the United Alloy Steel Corporation and Central Alloy Steel Corporation, after which he was for ten years employed by the steel and tube division of The Timken Roller Bearing Company as metallurgical engineer, specializing in alloy steel tubing applications in the various process industries.

He is well known for his work on the properties of metals at elevated temperatures and has contributed many articles to the literature on this subject.

Mr. Wilson is active in the affairs of the American Society for Metals, of which he is a former trustee, and in the American Society for Testing Materials, the American Society of Mechanical Engineers, the American Petroleum Institute and in the American Welding Society.

Gordon Groth has been appointed assistant to the president of the Pennsylvania Rubber Company, Jeannette, Pennsylvania, Howard W. Jordan, president, announced recently.

Mr. Groth came to Pennsylvania from Carnegie-Illinois Steel Corporation in Pittsburgh, where he served as contact engineer in the structural and plate division. He was active in the steel artillery cartridge case program and worked closely with the War Production Board.

Previously he was affiliated with the Simmons Manufacturing Company of Cleveland and Ashland, Ohio, as vice president and general manager.

SLUDGE

Needs no introduction

Every fuel oil user is familiar with the evil effects of sludge in the oil system — clogged lines, preheaters, strainers, burners — poor combustion — loss of oil — loss of production.

DACAROL fuel oil treatment dissolves existing deposits and prevents future deposits in oil systems. Need we say more?

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THEN JUDGE FOR YOURSELF

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DACAR CHEMICAL PRODUCTS COMPANY

Wabash and McCartney Streets Pittsburgh, Pa.

ELECTRIC OVERHEAD TRAVELING CRANES
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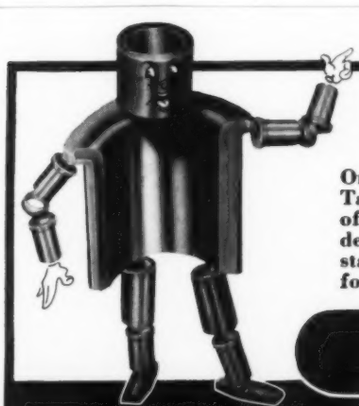
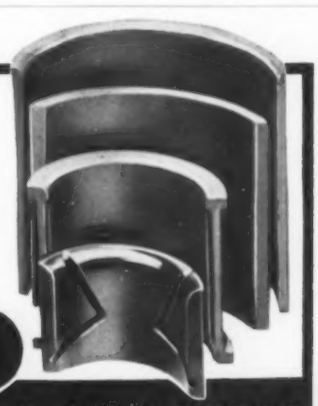


MODERN BEARINGS for MODERN NEEDS

On Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes and other tough jobs the many types of GATKE Fabric Bearings offer mighty aid in eliminating delays and avoiding costly machine shop work. An installation on your toughest service will show you. Write for particulars.



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Specialists for over a generation in

OIL IMMERSED MOTOR CONTROL

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Engineers — Consultants — Contractors
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Blast Furnace Copper Castings • Roll Neck Bearings • Housing Nuts • Machinery Castings • Acid Resisting Castings • Phosphorized Copper • Locomotive and Car Journal Bearings • Babbitt Metals
NBM
NATIONAL BEARING METALS CORP.
ST. LOUIS • PITTSBURGH • NEW YORK

E. B. Farris, formerly connected with Edgar T. Ward Sons Company, Cleveland, Ohio, was recently appointed to represent the steel division of the Copperweld Steel Company of Warren, Ohio.

His headquarters are in the Cleveland office of the Copperweld Steel Company.

F. N. Keithley has been appointed district engineer of the Thermit Department by the Metal and Thermit Corporation, 120 Broadway, New York, New York. His headquarters will be at the corporation's South San Francisco branch.

Mr. Keithley has been associated with the Metal and Thermit organization since 1908. He transferred from the Jersey City plant in 1922 to the west coast, where he has since been engaged in sales and service work in connection with Thermit welding and Murex electrodes.

Roland Whitehurst, assistant sales manager of The Electric Storage Battery Company since 1940, has been assigned the title of sales manager, effective January 1, 1944. Mr. Whitehurst has been in the employ of the company since 1908, and was manager of its Washington branch for 20 years.

M. D. Howell has been appointed to the position of assistant to president, a newly created post, it was announced by the United States Steel Corporation of Delaware.

The appointment of Mr. Howell, who will continue as vice president, secretary and treasurer of the Delaware Corporation, in addition to his new duties, became effective January 1, 1944.

Mr. Howell presently coordinates the activities of the corporation relating to government finance facilities, amortization, renegotiation and termination of war contracts and production planning, and in his new position will be assigned additional special duties by the president.

Mr. Howell was formerly vice president of Carnegie-Illinois Steel Corporation, prior to which he was a vice president of the Chemical Bank and Trust Company of New York.

Benjamin F. Scott, formerly superintendent of the 30-inch hot strip mill at Otis works, Cleveland, of the Jones and Laughlin Steel Corporation, has been appointed steel order supervisor, a newly-created position. He is succeeded by **William J. Leahy** who was formerly superintendent of the 77-inch hot strip finishing department. **George R. Seeley,** in addition to his duties as superintendent of the blanking department has been appointed superintendent of the 77-inch hot strip finishing department to succeed Mr. Leahy.

The three men have gained practically all of their business experience with Otis, Mr. Scott having been with the organization since 1916, Mr. Leahy since 1914 and Mr. Seeley since 1925.

H. W. Erler, formerly superintendent of No. 1 open hearth at the Gary works, Carnegie-Illinois Steel Corporation, U. S. Steel subsidiary, was made superintendent of No. 4 open hearth, replacing S. L. Moffatt, resigned. Mr. Erler has been employed at Gary works in open hearth operations for the past 21 years.

W. G. Hoffman was appointed superintendent of No. 1 open hearth, replacing Mr. Erler. He had been assistant superintendent of No. 1 since August, 1942, having served in the open hearth department for 20 years.

Ross Sibley replaces Mr. Hoffman as assistant superintendent of No. 1 open hearth. An Emerson High School graduate, he was intermittently employed at

Gary works from 1918 until 1926 when he began his continuous service for the corporation.

Bruce A. Fleming has been elected vice president in charge of sales at Edwin L. Wiegand Company, Pittsburgh, manufacturers of Chromalox electric heating units and equipment. He succeeds **Ernest N. Calhoun** who recently became president of the company.

Mr. Fleming has been associated with the appliance industry for the past 15 years, having been active in the appliance promotion of the National Electrical Manufacturers Association and the Modern Kitchen Bureau.

Obituaries

Charles J. Mayer, president and founder of the Electric Service Supplies Company, Philadelphia, succumbed to a long illness at Ventnor City on December 19. He was 77 years of age.

CHARLES J. MAYER

Long a resident of Philadelphia, Mr. Mayer was a pioneer in the street railway industry, having founded one of the first companies to serve the street railways in 1895 under the name of Mayer and Englund Company, Philadelphia. Prior to that time Mr. Mayer was associated with the R. D. Nuttall Company. In 1906 the Mayer and Englund Company and others were consolidated into the present Electric Service Supplies Company.

He was a member of the American Transit Association, Edison Electric Institute and many other associations.

William F. James, of the Westinghouse Electric and Manufacturing Company, died after a two years' illness at his home in Philadelphia. He was 64.

Mr. James was born October 12, 1879, in Philadelphia. After attending schools in this city, he was employed by the Westinghouse Company, toward the end of the last century. Remaining with them, he specialized in the development of its sales organization.

IMO OIL PUMP
Easy to pack
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I MOVE OIL
The De Laval IMO
rotary displacement pump for fuel and lubricating oils has only one stuffing box. It has been designed with the operator's problems in mind. Ease of packing is only one of the important and exclusive features.
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IMO PUMP DIVISION
of the De Laval Steam Turbine Company, Trenton 2, N. J.

Well-known Industrial Instrument Company desires to expand Sales Organization looking forward to post war activities. Splendid opportunity for technically trained engineers, preferably with chemical or mechanical background. Nature of work requires persistence and ability to cooperate as a consultant with prospects rather than high pressure selling. Locations open are Boston, New York, Philadelphia, Pittsburgh, Cleveland, Milwaukee, Indianapolis, North Carolina, Kansas City, Houston, Los Angeles, and San Francisco. Write Box 299, Iron and Steel Engineer, 1010 Empire Bldg., Pittsburgh, Pa.

Plant Maintenance Superintendent for Eastern plant engaged in metal manufacture. Must be able to take complete charge of all equipment, installations and repairs as well as building maintenance. Full knowledge of electrical equipment including such as operate on electronic principle. Must be competent to direct large force of maintenance workers. The company is one of the leading metal manufacturers and offers excellent after war opportunities. Apply by letter giving full particulars and salary desired. State age, height, weight and when available. Address G-75, P. O. Box 3495, Philadelphia, Pennsylvania.

CHOOSE OKOPRENE*

PORTABLE CORDS FOR LONG LIFE

Specify OKOPRENE, the next time you're selecting portable cords and cables that must withstand severe operating conditions.

OKOPRENE-sheathed cords and cables offer maximum protection against such deteriorating elements as heat, ozone, moisture, lubricants, cutting oils, acids, alkalies and other corrosive chemicals.

In addition, the toughness, flexibility and abrasion resistance of OKOPRENE mean unexcelled ability to stand up under general mechanical abuse.

OKOPRENE-protected cords and cables are available in all standard sizes and constructions, subject to WPB limitations. Use them for portable tools and lamps, welding and riveting cords, reel cables and portable power cables. The Okonite Company, Passaic, New Jersey.

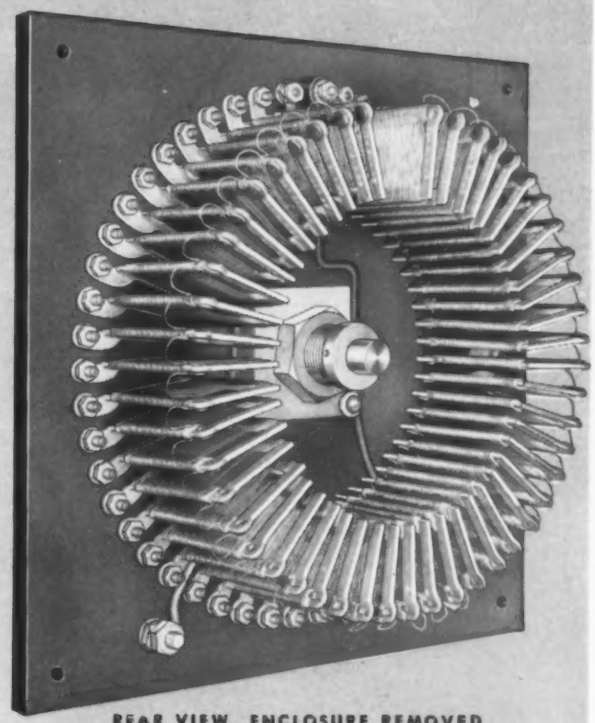
* A rugged sheath compounded with neoprene. OKOPRENE's all-around resistance reduces repairs and extends service life far beyond that of ordinary cable coverings.

3505

OKONITE INSULATED WIRES AND CABLES

HEAVY DUTY MILL FIELD RHEOSTATS

FRONT VIEW, STANDARD ENCLOSURE



REAR VIEW, ENCLOSURE REMOVED

"3C" Heavy Duty Mill Field Rheostats feature extra sturdy construction to provide long life and trouble-free operation.

The buttons on the Monson slate face are hard drawn brass, accurately machined to prevent stubbing.

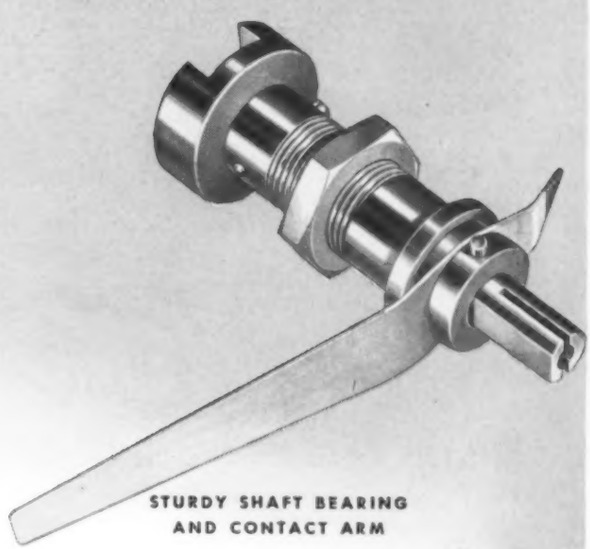
The shaft is cold drawn steel operating in a brass bearing ⅝" x 2½" long.

The contact arm is one piece of heavy Phosphur Bronze, rigidly connected to the shaft. The shaft has a flat side to prevent relative motion.

An Indicating Dial, with a point for each button is provided, with space for operator's markings.

Resistors are made with wire, non-corrosive in normal atmospheric conditions.

Tandem and Motor operated Rheostats are available.



STURDY SHAFT BEARING AND CONTACT ARM

Ask for fully descriptive Bulletin 125

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO

Stop Short Circuits Reduce Motor Upkeep Cost

Steel plant motors are subject to vibration. This aggravates the leaking habits of ordinary oil, so that it escapes from bearings and is thrown onto windings, causing short circuits.

NON-FLUID OIL corrects this evil and reduces cost. It does not creep or throw, thus outlasts oil 3 to 5 times.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

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NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

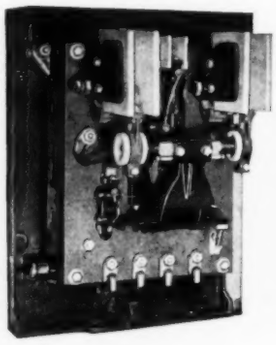
Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

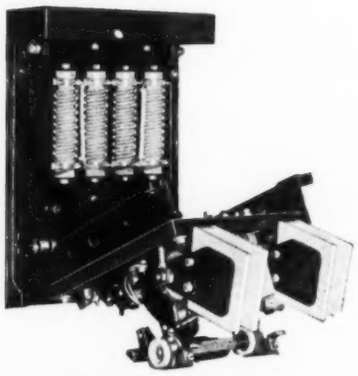
OHIO

QUICK DROP MAGNET CONTROLLER

With arc suppressor and quick drop, automatic for any class of material.



Closed



Open for Inspection

Two main switches open circuit in series. Reverse and quick drop are automatic. Master contacts carry control circuits only.

The arc suppressor reduces the arc so it is not harmful or disagreeable. Contact tips are thus saved. Arc shields do not burn.

This controller makes possible 6 or more lifts per minute which is as fast operation as any we have ever observed in practice.

•

OHIO reliable MAGNETS

The Ohio Electric Manufacturing Company

5907 Maurice Ave., Cleveland, Ohio

DON'T NEGLECT THE BRUSHES

IN WARTIME—OR AFTER

The little brush always gets the blame, but now always the attention. Service the current-collecting parts of your motors and generators to help get peak efficiency. Here are some tips:

KEEP BRUSH HOLDERS CLEAN AND AT CORRECT TIGHTNESS

Holders should be free from roughness, dirt or gummy substances. See that they are straight, that they don't jam the brushes, or permit brushes to shift position while running. Replace worn holders.

WATCH SPRING PRESSURES

Make sure that all pressures are uniform to avoid selective action. If in doubt about correct pressures, write SPEER.

KEEP BRUSHES CLEAN AND PROPERLY SURFACED

An approved method is illustrated above. Press brush down in a strip of sandpaper placed between brush and commutator. Hold paper flat, and make several passes.

SEE THAT SHUNTS ARE TIGHT AND CORROSION-FREE

Consult SPEER FOR THE RIGHT BRUSH GRADES

Real brush troubles can often be traced to wrong applications. If any brushes are not giving maximum performance, maybe the brush grade is at fault. Do this to find out: Send for a SPEER Brush Data Form, one for each machine to be checked. Fill out forms and return them. SPEER engineers will then make careful recommendations — based on 45 years of commutation experience. There's no charge for this counsel, and it may improve operation of your machines. Write for all the forms you need — on your business stationery please.

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BACK THE ATTACK—BUY MORE WAR BONDS

5159.

And more steel means more War Bonds for most of the men in the mills. They're getting bigger tonnage, better finish, fewer rejects and less time out for roll change when Lewis Rolls are in the stands.

LEWIS FOUNDRY & MACHINE DIVISION of Blaw-Knox Company
P. O. BOX 1586, PITTSBURGH, PA.

BUY U. S. WAR BONDS AND STAMPS

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and non-ferrous industries

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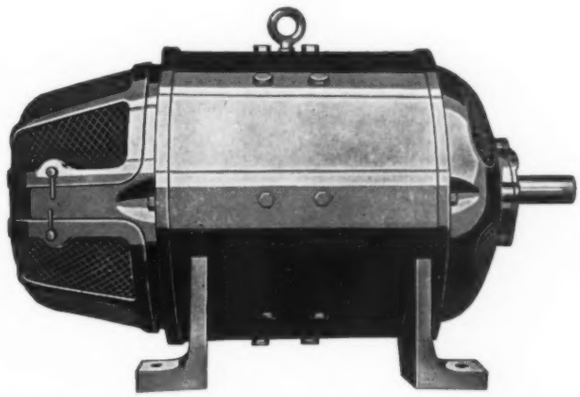
QUICK REVERSE!

The ability of the electric motor, with suitable control, to do a special and difficult task on production machinery is well demonstrated by the reversing motor-drive as worked out by Reliance engineers for a variety of applications.

This drive is automatic, direct, positive and reliable. Automatic reversal at any desired point in a cycle of operations can be provided. It can be combined with speed control and safety features. Maintenance costs are less.

Pioneering work by Reliance men in making use of these characteristics has paid out in simplified machine design, faster operation, reduced maintenance requirements and increased safety. Complete information is yours for the asking.



"Know how" in both electrical and mechanical design, translated into special mechanical parts and electrical characteristics, plays a big part in the fast and dependable operation of Reliance Reversing Motor-drive.

RELIANCE A-C D-C MOTORS

RELIANCE ELECTRIC & ENGINEERING CO.

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Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S.C.) • Houston • Los Angeles • Minneapolis • New York Philadelphia • Pittsburgh • Portland (Ore.) • St. Louis • Salt Lake City • San Francisco • Syracuse • Washington, D. C. • other principal cities.

ROCKBESTOS A.V.C. Wires and Cables

Provide the most direct approach to eliminating wire failures in lighting, control and power circuits

THE ROCKBESTOS CONSTRUCTION THAT PROVIDES LONG WIRE LIFE*

1. The conductor is perfectly and permanently centered in helically applied insulation.
2. Impregnated felted asbestos insulation withstands conductor-heating currents and won't burn, even under overloads up to the melting point of copper.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance, protected from heat, flame and oxidation between two felted asbestos walls.
4. Outer felted asbestos wall impregnated with heat, flame and moisture resistant compounds serves as a heat-barrier against high ambient temperatures.
5. A tough, rugged asbestos braid, resistant to heat, flame, moisture, oil, grease and corrosive fumes.

**One of 122 different wires and cables developed for severe operating conditions by Rockbestos.*

WON'T bake brittle, bloom, burn or rot.
RESISTS moisture, oil, grease and fumes.

Rockbestos A.V.C. Power Cable above and similarly insulated Motor Lead Cable (Underwriters' and Nat. Elec. Code, Type AVA) has a maximum operating temperature rating of 110° C. (230° F.) and this permanently insulated construction. See detail, upper left.

600 VOLT A.V.C. BOILER ROOM WIRE—TABLE C
(Underwriters' Type AVA)

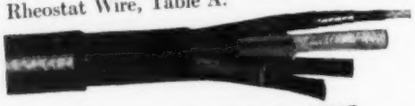
Sizes No. 18 to 4/0 AWG. This construction for sizes 18 to 8, sizes 6 to 4/0 have another wall of impregnated asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A.V.C. construction is ideal.

600 VOLT ALL-ASBESTOS RHEOSTAT CABLE—TABLE R
(Underwriters' Type AI)

Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of impregnated asbestos, covered with a rugged asbestos braid in black, white or colors.

Use this power and rheostat cable for wiring rheostats, elevator and locomotive control panels, and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.



600 VOLT A.V.C. CONTROL CABLE

In one to 19 conductors. Standard stranding AWG No. 12—19/-25 and No. 9—19/-22. Other strandings furnished on order.

Designed for use under conditions too severe for control cables with other insulations which deteriorate rapidly when exposed to high temperatures. Operates without failure under attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

FOR VICTORY BUY WAR BONDS

There are two ways to practically eliminate wire-failures in electrical circuits around furnaces, soaking pits, steam tunnels, lehrs, kilns and other high temperature locations. One is to move the circuits away from the "hot-spot" area, but that might be impossible or too costly. Another, is to install wire with an insulation that is unaffected by heat and built to stand up under severe operating conditions.

Rockbestos A.V.C. wires, cables and cords are designed and constructed to provide lasting trouble-free performance. They stand up where other wires fail because the *permanent* impregnated asbestos insulation resists heat and moisture, oil, grease, alkalies and corrosive fumes, and won't bake brittle, crack, flow, rot or swell.

Get the facts on Rockbestos A.V.C. See for yourself how these *permanently insulated* wires and cables keep wire-failure down to the minimum in lighting, power and control circuits. When inquiring or ordering, please furnish CMP allotment number and certification. For complete information and samples, write nearest branch office or:

Rockbestos Products Corporation, 925 Nicoll Street
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ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

FARREL

ROLLING MILL DRIVES AND PINION STANDS

FARREL-BIRMINGHAM heavy duty rolling mill gear units and pinion stands are specially designed to suit individual conditions. They are built to stand up under the stresses and shocks resulting from the high speeds and heavy loads encountered in modern mill practice, yet they are made with a high degree of precision to provide the smoothness of operation which is as essential in large mill drives as in smaller machines.

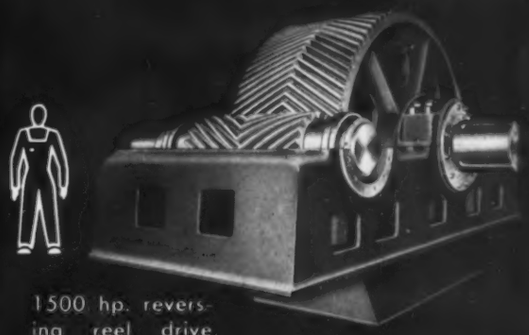
These drives have beds of cast steel, Meehanite or welded steel construction. Double-walled or single-walled deep base is used, depending on load conditions and rigidity requirements. Bearings may be either plain babbitt-lined steel cartridges or any approved make of anti-friction bearing.

Gears are usually continuous tooth herringbone — *The Gear with a Backbone* — accurately generated by the Farrel-Sykes process. Single helical or a combination of single and double helical gears can also be furnished. Dependent upon conditions or requirements, lubrication may be by dip and splash system, by pump built into the unit and driven by one of the shafts, or a separate lubrication system.

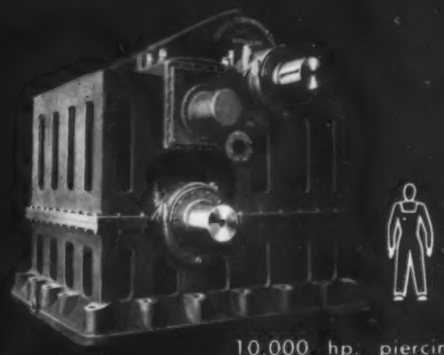
Our engineers will be glad to discuss drive problems with you at any time. No obligation of course.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

Plants: **Ansonia and Derby, Conn., Buffalo, N. Y.**
Branch Offices: **New York, Buffalo, Pittsburgh, Akron, Los Angeles**

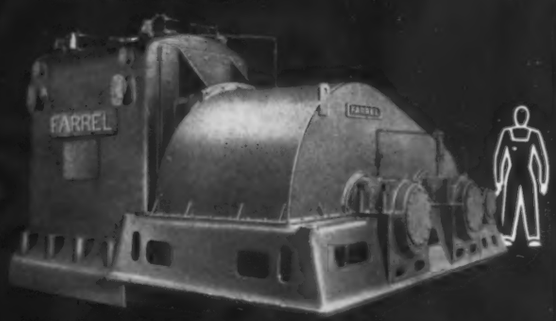


1500 hp. reversing reel drive with the cover removed to show the Farrel-Sykes continuous tooth herringbone gears.



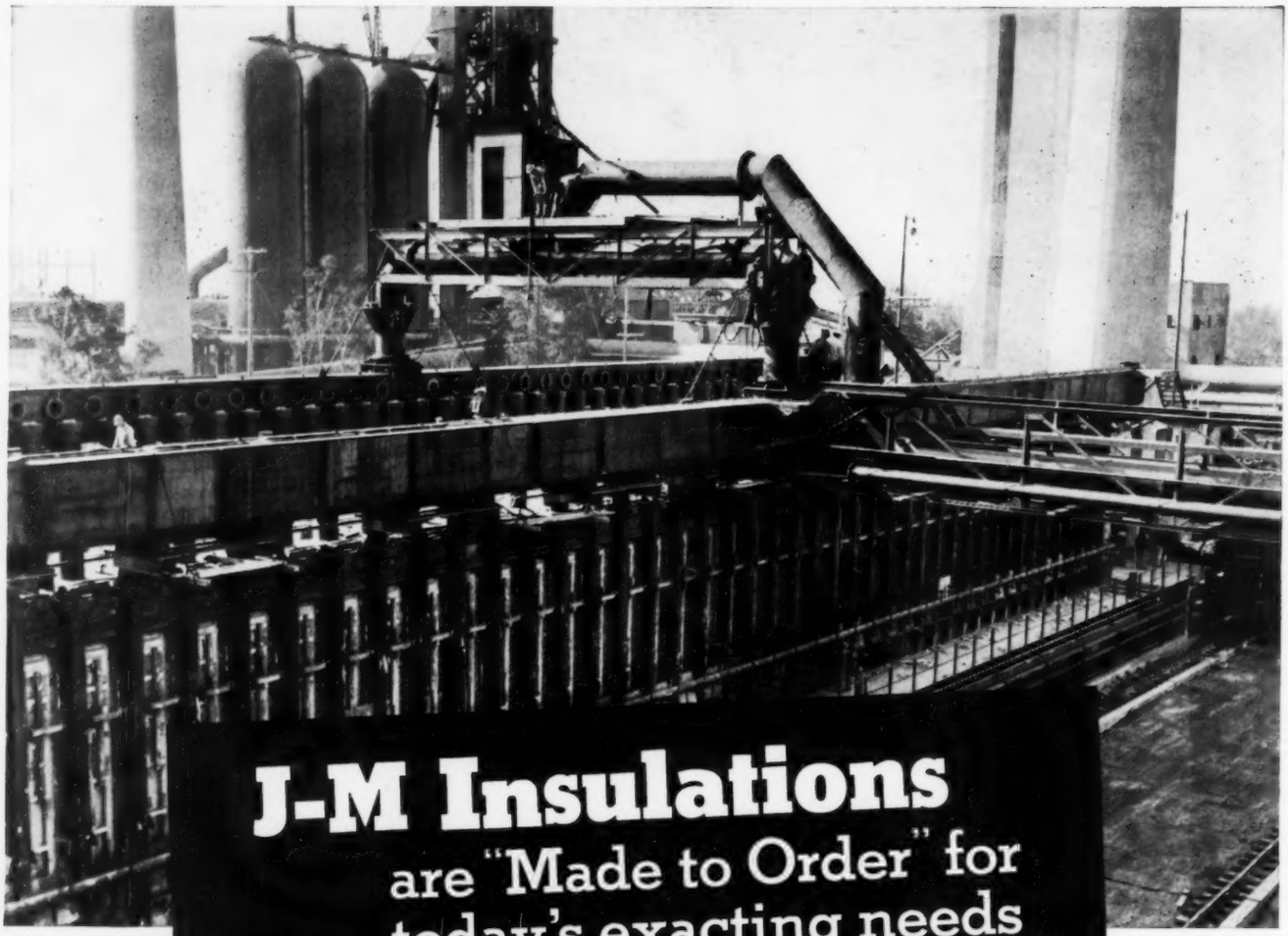
10,000 hp. piercing and expanding mill drive.

4000 hp. pinion stand for four-high reversing cold strip finishing mill.



Combined double reduction drive and 44" pinion stand for 40" x 108" reversing mill.

Farrel-Birmingham



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are "Made to Order" for today's exacting needs

J-M Industrial Insulations cover every type of heat control. Each type of insulation is tailor-made to fit the particular job for which it was designed. In addition: Johns-Manville's 85 years' experience in every conceivable type of insulation problem makes it possible for J-M Engineers to design insulation applications for special conditions with utmost speed, thoroughness and economy. Following are just a few of the many types of J-M Industrial Insulations:

INSULATION FOR TEMPERATURES TO 1900° F. J-M Superex Blocks have long been standard for this service. High heat resistance, low thermal conductivity. Sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

FURNACE INSULATION UP TO 2600° F. J-M Insulating Brick and Insulating Fire Brick are available in 7 types, with temperature limits ranging from 1600° F. to 2600° F. All provide light weight, low conductivity.

FOR TEMPERATURES TO 600° F. J-M 85% Magnesia has been for many years the most widely used block and pipe insulation for temperatures to 600° F. and, in combination with Superex, for higher temperatures. Maintains high insulating efficiency. Standard block sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

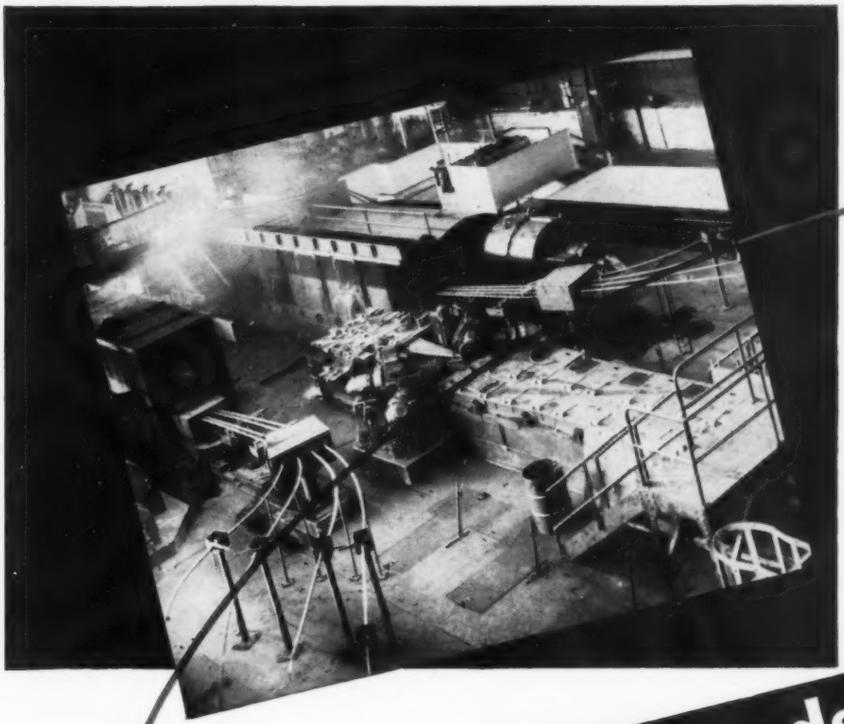
FOR STEAM LINES UP TO 700° F. J-M Asbesto-Sponge Felted Pipe Insulation is recommended where maximum efficiency, high salvage and resistance to abuse are essential. For temperatures over 700°, used in combination with Superex. It is available in 3-ft. lengths, from 1″ to 3″ thick, for standard pipe sizes.

SIL-O-CEL C-3 CONCRETE—Cast on the job from Sil-O-Cel C-3 aggregate and cement. Sets up into a strong, durable semi-refractory insulating concrete for temperatures up to 1600° F. Crushing strength: 1000 lbs. per sq. in.

For details on these materials, and on the complete J-M Insulation line, write for Catalog GI-6A. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
INDUSTRIAL INSULATIONS
FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE



A Bright Wire Goods Future

. . . worth many miles of wire rod.

One new cup hook in ten million homes is a big order . . . but it's only a small part of the new tonnage piling up for V-Day. Chain Store buyers anticipate an *immediate* postwar demand for bright wire goods alone that will be 600% of prewar requirements.

To make these and other goods available at non-inflation prices requires mass production facilities that start with *accurate* wire rod.

MORGAN CONSTRUCTION CO.
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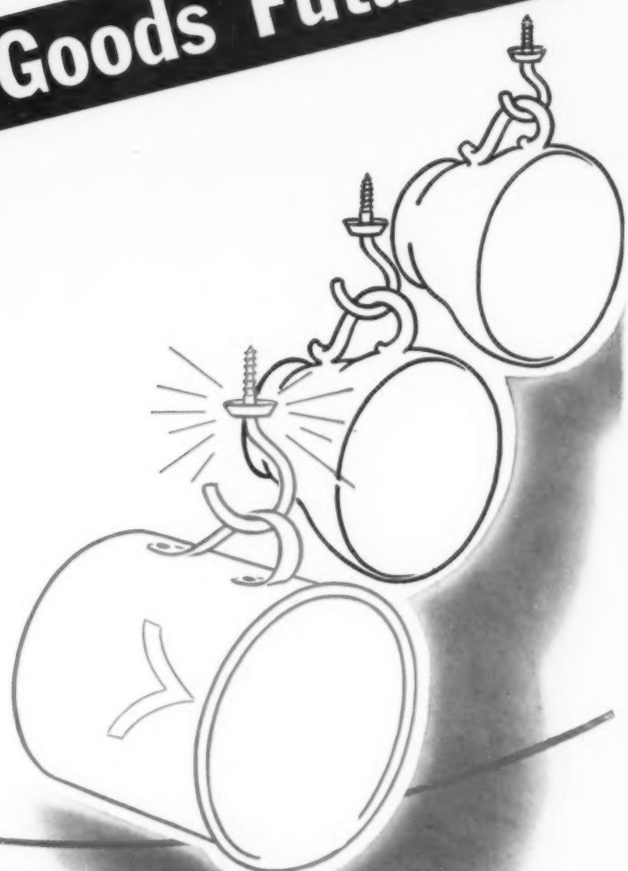

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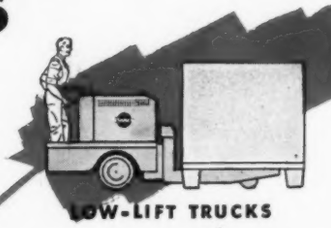
WIRE MILLS . . . REGENERATIVE FURNACE CONTROL

NEW Baker Truck Catalog GIVES THE ANSWERS TO YOUR MATERIAL HANDLING PROBLEMS

Here's real help for any plant or warehouse faced with transportation problems. The Baker Electric Truck Catalog No. 52 is more than a catalog. It is a handbook of information on material handling with power trucks, designed to facilitate selection of the proper equipment for any set of requirements. In addition to describing the 47 standard Baker Electric Trucks, it covers many special models designed for unusual handling operations.

Actual case histories featured throughout the book show Baker Trucks of all types speeding production, saving time and money and conserving man-power in a wide variety of installations. You are almost sure to find problems comparable to those in your plant, and you can profit from the experience of others in solving them.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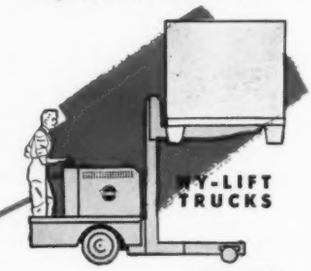
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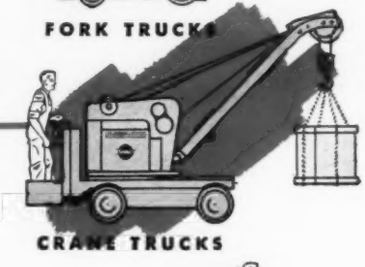
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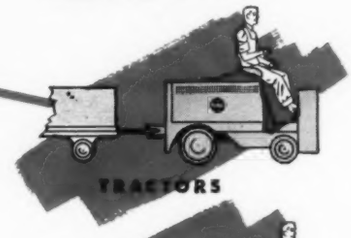
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PLATFORM TRUCKS

Plant and production managers, traffic managers, superintendents, purchasing agents and any others concerned with material handling will find this book a valuable source of information. Write for your copy of The Baker Electric Truck Catalog No. 52 today.

BAKER INDUSTRIAL TRUCK DIVISION

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In Canada—Railway and Power Engineering Corporation, Ltd.

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● Type H Heavy Duty Worm Gear Reducers driving 54-in. and 48-in. tumbling mills in steel foundry. Ratio 11-1/3 to 1 and 7-3/4 to 1.

TODAY every phase of war work calls for drives that will stay on the job. Jones Worm Gear Speed Reducers have been built for long, trouble-free service. And the records established by these speed reducers in 24 hour a day service show that they have the ruggedness and stamina for which all Jones Transmission Products are known.

For complete information on Jones Worm Gear Speed Reducers ask for Bulletin No. 68 and for Worm-Helical Reducers ask for Bulletin No. 75.

● Jones Worm-Helical Speed Reducer driving a lacquer agitator. A simple design prevents leakage of oil along the vertical low speed shaft.

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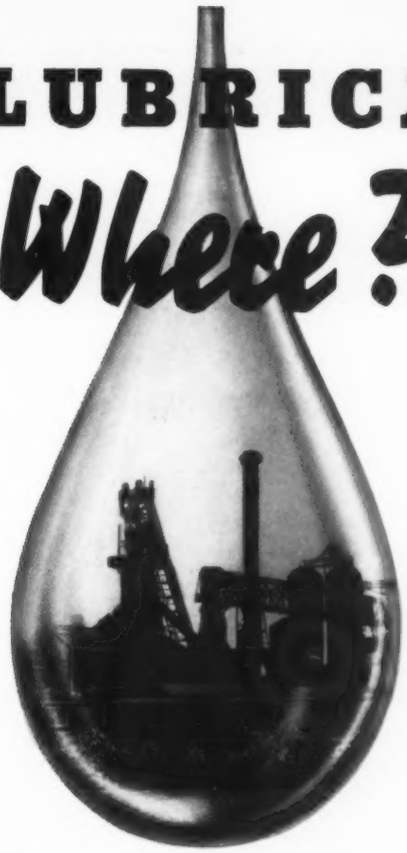
WHAT LUBRICANTS . . . *Where?*



An ever-present problem on which Houghton can help

Steel mills have long since passed through the era when oil was "just oil". They have lubrication engineers whose job it is to lick the trouble-spots and to train men to lubricate intelligently so as to prolong the useful life of massive machines.

Those men know, for the most part, how science has been able to improve on nature through the fortifying of good oils to enable them to protect metal surfaces from wear. How important lubrication is to the mill can be seen by examining the pages of this publication filled with discussion on this vital subject.

Houghton's place in lubrication may be described as "specialists on a volume basis". Some of these applications where Houghton "fortified" lubricants are doing a fine job are listed at the left.

Our technical services to diagnose lubrication troubles and suggest remedies—based on more than 70 years in the business of improving on natural petroleum stocks—are freely available. Write—

Ask about
HOUGHTON LUBRICANTS FOR THESE USES:

Hand Guns and pressure systems
Roll Necks
Open or closed housings
Transmissions
Mill Reduction Gears
Roller Bearings
Worm Drives
Mill Screws
Heating Furnace Cranes
Cover Journals
Table Bearings
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Mill Pinions
Runout Tables
Flying Shears

E. F. HOUGHTON & CO.
PHILADELPHIA
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HOUGHTON'S *Fortified* OILS and GREASES

WAGNER PRODUCTS SPEED VICTORY!

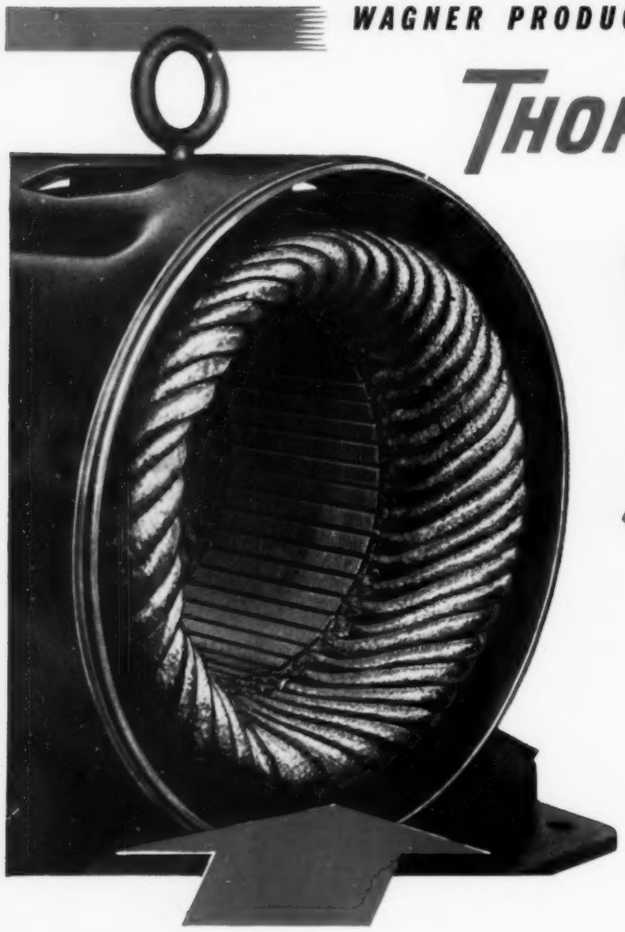
THOROUGH INSULATION

...IS ONE OF THE REASONS WHY

Wagner

MOTORS

Stay on the job!



The illustrations on this page show typical polyphase stator windings. The stator cores of all Wagner polyphase motors are well insulated, using special slot cells formed from tough fibrous material, cuffed on each end for extra strength.

The coils and free-ends are shaped to fit snugly into the slots so that there is no possibility of vibration and at the same time the windings are easily put into place.

Heavy separators are used between the coils in the slot and inverted U-shaped cells fit over the tops of the coils under the slot wedges. The free-ends of the windings are completely taped well into the slot cells, and heavy sheets of black varnished muslin are slipped between the coils of the various phases to insulate them from each other.

After the windings are in place, the stator is baked to remove all moisture, and while still hot it is immersed in a heavy insulating varnish. When the heated stator core is immersed in the much cooler varnish a suction is created which produces complete impregnation of the windings.

The stator is immersed long enough so that the insulating varnish impregnates the innermost portions of the coils. The stator is then baked again until this coating is completely dried. It is then given another dipping and baking to insure complete impregnation and to provide an added moisture-resisting coating.

Finally, the stator is sprayed with air-drying varnish, which not only provides further resistance to oil and moisture, but also gives the coils a glossy surface.

M43-17

WRITE FOR COMPLETE INFORMATION

Complete information on Wagner motors will be sent upon request. Wagner is a nation-wide organization with branches in twenty-nine principal cities. Each branch office is manned by trained field engineers ready to help you solve your motor-drive problems.

Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

STARTING JANUARY 18TH

IT'S UP TO YOU!

STARTING January 18th, it's up to you to lead the men and women working in your plant to do themselves proud by helping to put over the 4th War Loan.

Your Government picks you for this job because you are better fitted than anyone else to know what your employees can and should do—and you're their natural leader. This time, your Government asks your plant to meet a definite quota—and to break it, *plenty!*

If your plant quota has not yet been set, get in touch now with your State Chairman of the War Finance Committee.

To meet your plant quota, will mean that you will have to hold your present Pay-Roll Deduction Plan payments at their peak figure—*and then get at least an average of one EXTRA $100 bond from every worker!*

That's where your leadership comes in—and the leadership of every one of your associates, from plant superintendent to foreman! It's your job to see that your fellow workers are sold the finest investment in the world. To see that they buy their share of tomorrow—of Victory!

That won't prove difficult, if you organize for it. Set up your own campaign right now—and don't aim for anything less than a 100% record in those *extra* $100 bonds!

And here's one last thought. Forget you ever heard of "10%" as a measure of a reasonable investment in War Bonds under the Pay-Roll Deduction Plan. Today, thousands of families that formerly depended upon a single wage earner now enjoy the earnings of several. In such cases, 10% or 15% represents but a paltry fraction of an investment which should reach 25%, 50%, or more!

Now then—Up and At Them!

Keep Backing the Attack!—WITH WAR BONDS

This advertisement prepared under the auspices of the United States Treasury Department and the War Advertising Council

NEW AIR VALVE

ASSURES POSITIVE AND ACCURATE CONTROL---

DOUBLE 4 WAY HAND OPERATED

A new application of the Quick-As-Wink Valve design is illustrated above. This setup is particularly adapted to air-operated clamps, fixtures, and knives, as well as to similar uses where one point of control becomes a convenient production method. The valve simplifies and facilitates control where two individual air cylinders lead and lag each other. It assures more positive and accurate control, saves air, and effects economies in piping. This valve permits 2, 3, or 4-way operation.

Write today for a Quick-As-Wink catalog. In it you will find a long-life, leak-proof valve, hand or mechanically operated, for any air or hydraulic control problems you may have. If the answer to your needs is not shown in the catalog, Hunt engineers will build a special valve for you.

C. B. HUNT & SON

THE HIGHER THE PRESSURE — AIR WATER OIL — THE TIGHTER THE SEAL

1863 PERSHING ST. SALEM, OHIO

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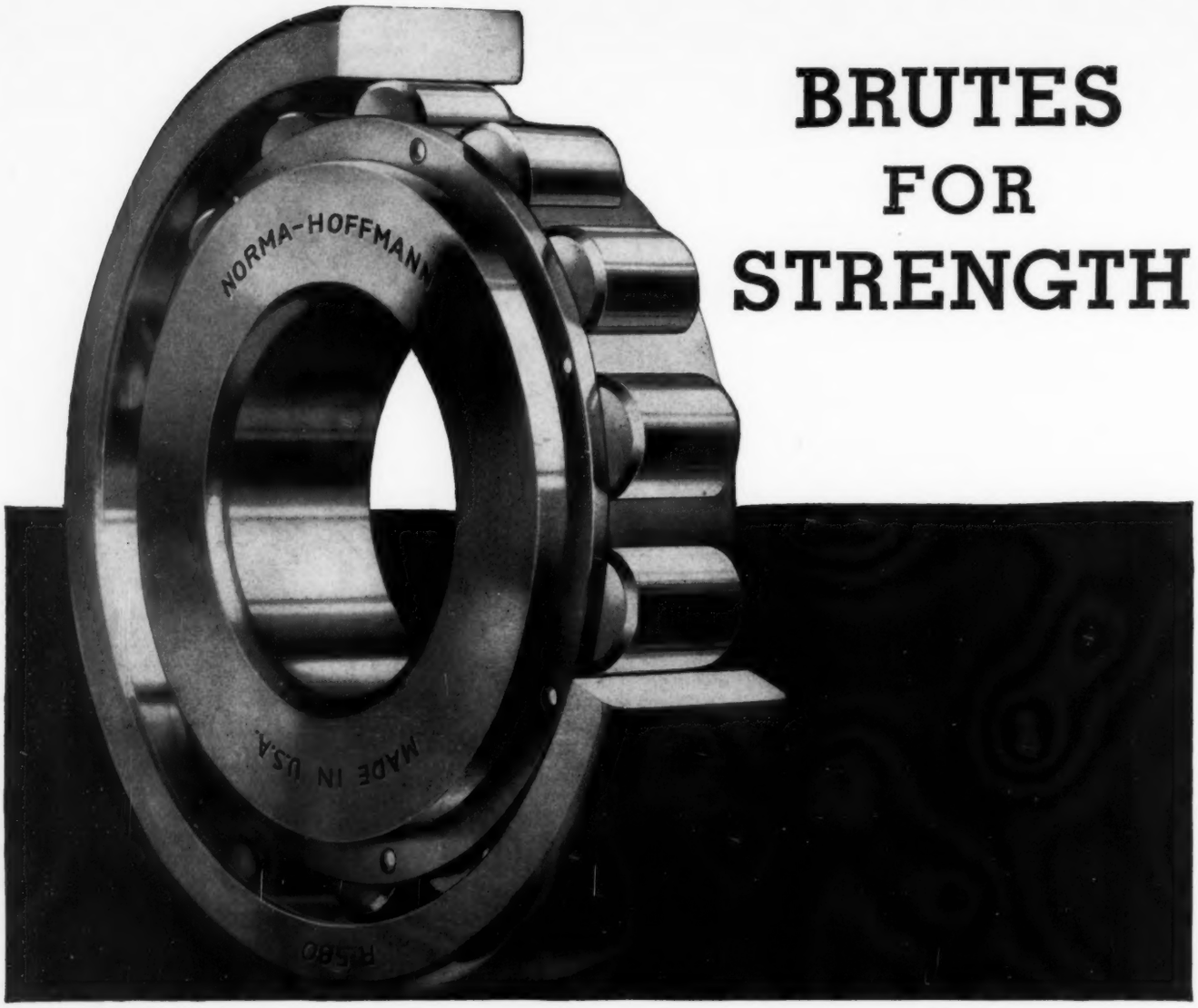


BRUTES FOR STRENGTH

THE outstanding performance records made by NORMA-HOFFMANN PRECISION ROLLER BEARINGS under the heaviest and most exacting duties, are the logical result of the following distinctive factors:

Full line contact of rolling surfaces, affording a larger radial load capacity for continuous and intermittent service than any other type of single-row bearing, and providing a temporary overload capacity 50% above normal catalog rating, with greater resistance to shock and vibration.

Highly durable, completely machined and balanced bronze retainer riding on inner ring shoulders and minimizing internal load.

Lower frictional coefficient under heavy loads than any other single-row anti-friction bearing—due to extreme precision and design characteristics.

Test these PRECISION ROLLER BEARINGS in your own hardest service; remember that they have all the high speed qualities of the best ball bearings, and are interchangeable, size for size, with all single-row metric ball bearings.

Write for the catalog. Let our engineers work with you.

"NORMA-HOFFMANN"

PRECISION BALL, ROLLER and THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORPN., STAMFORD, CONN. U.S.A.

ALL FOR STEEL MILLS . . . ALL BY I-T-E

To meet different needs in protecting and controlling steel-mill electrical systems, I-T-E provides variety of equipment. Each kind has its place. Together, the types of apparatus give opportunity to make a selection in exact keeping with specific conditions.

FB CIRCUIT BREAKERS

KLAMP-TITE SWITCHES

MT CIRCUIT BREAKERS

SWITCHGEAR

AUTOMATIC RECLOSING CIRCUIT BREAKERS

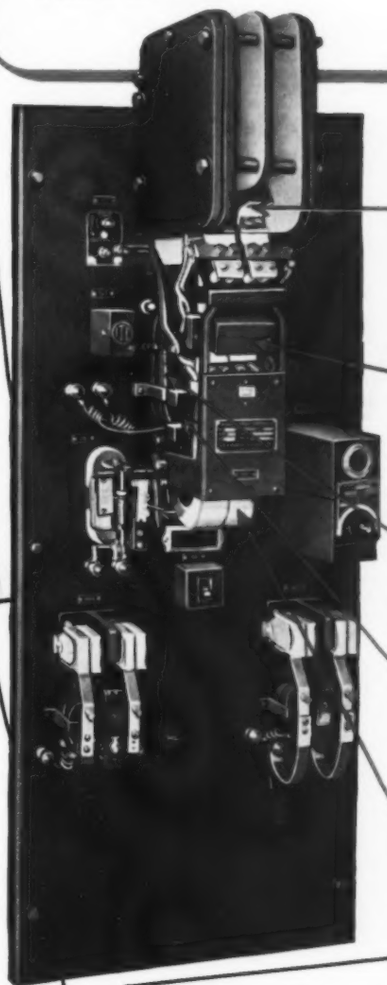
The ability of automatic reclosing circuit breakers to restore service as soon as a fault has been cleared, is recommending this type of protection to steel-mill engineers. Interest centers in d-c applications with which it is both safe and desirable to have the best possible continuity.

The type of automatic reclosing circuit breaker illustrated here recloses in direct response to line conditions, and these conditions are subject to preselection. It is a versatile device, adaptable to varying needs.

I-T-E engineers pioneered in the development of automatic reclosing circuit breakers, with the purpose of (1) reducing service outages, (2) confining electrical disturbances to local areas and (3) minimizing attendance. I-T-E experience in this field covers a period of more than twenty-five years.

Look into the possibilities of automatic reclosing circuit breakers of this type. Steel mills will be using more of them. Let I-T-E engineers give you a complete explanation of their usefulness.

Representatives in Principal Cities



ARCING CONTACTS are in the quickly-removable arc chute. They open after and close before the auxiliary and main contacts. A special non-welding alloy is used. A strong spring prevents "bouncing" and "freezing" of the contacts when closing against a heavily loaded line.

COMPRESSION SPRING applies 200 pounds pressure to the silver-surfaced main contacts when the circuit breaker is closed, assuring permanently high current-carrying capacity. Made of vanadium steel and enclosed, this spring is fully dependable.

CLOSING COIL is direct-acting with ample power to overcome the resistance of the contacts and the spring. The coil is impregnated with a special moisture-resisting compound to assure reliable service under adverse conditions.

ARMATURE is of laminated construction and attached directly to the contact-arm assembly. By loosening a thumb screw and lifting latches on either side, the armature and moving contacts may be pivoted forward for inspection.

LAMINATED CONNECTORS join moving contacts and lower current stud. Large radius bends and ample use of copper give high reliability and load-carrying capacity. All joints in the circuit are silver-surfaced.

KB CIRCUIT BREAKERS

KC CIRCUIT BREAKERS

I-T-E

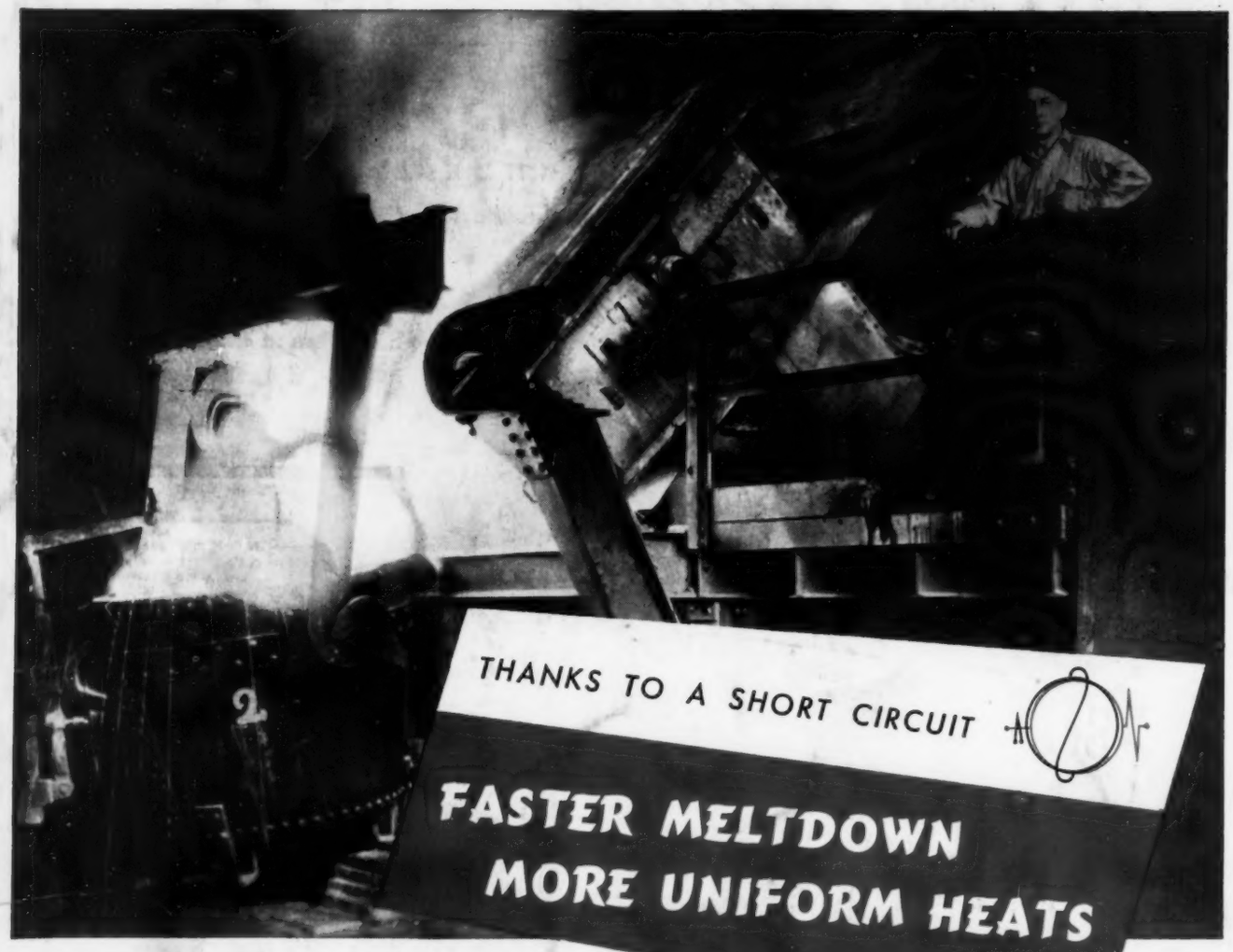
AIR SWITCHGEAR

IMMERSED IN AIR — ENCASED IN STEEL

The Army-Navy "E" for Production Excellence

I-T-E

CIRCUIT BREAKER CO., PHILADELPHIA 30, PA.



How induction-furnace power *is accurately controlled by the* AMPLIDYNE

Induction heating is faster, and temperatures are more easily controlled, when the high-frequency generator holds to the line—delivers practically *constant power input* to the furnace.

Used as exciters on many high-frequency generators, amplidynes hold voltage within extremely narrow limits. By their *forcing* action, amplidynes speed up the otherwise slow response of the heavy generators. Thus they quickly correct for wide load swings resulting from the changing resistance of the charge.

Voltage is back where it should be in 1/8th to 1/10th the time required with other types of regulators. On a 1250-kw generator, for example, it takes only 2½ seconds to bring power up from zero to full value. This means maximum melting rates *continuously.*

On the other hand, when it is desired to change quickly from one operating voltage to another, a simple change in dial setting is all that's needed. The amplidyne does the rest, insuring smooth, unerring power *and temperature* control.

Applied to high-frequency generators used in coreless melting, surface hardening, and heating for forging, as well as to many other types of steel-mill equipment, G-E amplidynes are revolutionizing automatic control. G-E engineers will gladly discuss the details with you. *General Electric Company, Schenectady, New York.*

SEND FOR YOUR COPY of "The Short Circuit That Moves Mountains." Thirty-six pages showing how G-E engineers, in designing the amplidyne, utilized a short circuit, together with load-current compensation, to produce a generator-type amplifier of almost instant responsiveness and having amplification factors ranging up to 10,000 to 1. Ask for Bulletin GEA-4055.

The best investment in the world is in this country's future—**BUY WAR BONDS**

GENERAL ELECTRIC

AMPLIDYNES